Self-Disclosure in Augmented Reality

By: Gal Hadad

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

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University of Haifa

Faculty of Social Science

Department of Information Systems

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ABSTRACT

Augmented Reality (AR) technology is a rapidly emerging medium characterized by the fusion of physical and digital realities. While AR has gained traction in various domains, its integration into social networks and social settings remains an emerging frontier. AR social networks can overlay digital enhancements onto people in real-world environments, creating mixed-reality experiences with novel opportunities for social interaction and information sharing. Addressing this emerging field, this study explores self-disclosure dynamics within AR social networks. It draws upon theories such as Social Exchange Theory, Privacy Calculus, and the Disclosure Decision Model. We explore three main research questions: 1) What motivates users to self-disclose in augmented reality social networks? 2) What risks do users perceive in self-disclosure within augmented reality social networks? 3) How do the drivers of self-disclosure identified in RQ1&2 influence user behavior across different contexts in augmented reality social networks? The study used a survey to assess participants' tendencies to share information in various social scenarios, which varied by size, context, and level of openness. Exploratory interviews followed the survey. The data was analyzed using a thematic analysis approach. Key findings reveal that self-disclosure in AR is driven by factors such as individual goals, subjective benefits, and perceived risks, which are significantly influenced by the situational context. Notable goals identified include identity clarification, which is more pronounced in AR than traditional online social networks, and relationship development. The study concludes that self-disclosure in AR is highly context-dependent, a finding primarily attributed to the varying risks, benefits, and types of information disclosed in different social scenarios. This underscores the need for privacy-conscious and user-centric design in AR social networks. It advocates for integrating context-sensitive privacy controls to foster user trust and engagement. Such an approach ensures that platform designs are aligned with the complexities and nuances of users' social interactions in AR environments, adapting to the specific characteristics of each scenario.

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1. INTRODUCTION

Self-disclosure (SD) is the act of revealing personal information to others, and it has been identified as a critical factor in relationship satisfaction and in developing and establishing relationships [14]. Self-disclosure has been studied in Human-computer interaction (HCI), specifically in the context of social networks, focusing on how and why an individual self-discloses, measuring the breadth (number of topics), depth (intimacy of the information) and duration of the information being disclosed [29], identifying factors such as privacy concerns, gender differences, trust in the technology, personal traits and the technological affordances of the medium [1,43].

Augmented Reality (AR) is an interactive experience that blends the real world with computer-generated content, covering various sensory modalities like visual, auditory, haptic, and more [36,38]. In the rapidly evolving digital technology landscape, AR has emerged as a groundbreaking advancement; its promise lies in the ability to offer contextually relevant data precisely when and where it's needed. Shared AR experiences expand this potential by allowing multiple individuals to view and interact with the same digital elements in real-time, creating a collective perception of augmented content that enhances group dynamics and engagement [8,32]. Companies like Google, Samsung, and Apple are leading the charge in developing AR wearables, such as smart glasses, which have the potential to not only change how individuals access information but also how groups collaborate and share experiences in AR spaces [47–51]. As AR technology introduces new ways of interacting with information and each other, it sets the stage for a new concept of digital communication: AR social networks. These networks will offer a unique layer of social interaction within the spectrum of shared AR experiences, where users can interact with one another in innovative and immersive ways[47–51]. Imagine, for instance, a social gathering where attendees can view information about each other through AR glasses, such as names or interests (see Figure 1). This situation presents a unique context for self-disclosure, very different from traditional online platforms where personal data is displayed on a webpage or from virtual reality environments where information is linked to a digital avatar. In AR, information is directly attached to the person in the physical space and visible to those in the immediate vicinity.

The concept of AR social networks is supported by the current presence of Virtual Reality (VR) social networks [4,18,43], which demonstrate the public's appetite for immersive social platforms. Additionally, the use of AR in existing social media platforms, as seen through popular filters and interactive features on apps like Snapchat, Instagram, and TikTok, indicates that AR technology is not only sought after but also actively being used for enhanced social engagement. Moreover, the availability of AR technology is rapidly increasing, with leading tech companies pushing the boundaries of AR wearables and making them more accessible to consumers. This confluence of technological advancement, existing VR social frameworks, and AR's integration into daily social media use provide a strong foundation for the emergence and potential success of AR social networks. Building on this foundation, this study aims to deepen the understanding of self-disclosure in AR social networks. It focuses on the nuanced and contextually rich nature of AR technology, which introduces unique considerations for social interactions. To unravel these complex dynamics, participants were familiarized with AR technology, and a mixed-methods approach involving surveys and exploratory interviews was employed. This comprehensive strategy allowed us to glean insights into their attitudes and decision-making processes concerning self-disclosure within AR settings, shedding light on an essential aspect of social connectivity in these mixed-reality experiences.

Our research identified the goals, benefits, and risks of users' self-disclosure in AR. By testing their reactions to having more control over the information and reciprocal disclosure, we found that participants highly valued these aspects. Additionally, we found that the risks and benefits associated with self-disclosure varied significantly across different scenarios, demonstrating that self-disclosure in AR is highly context-dependent.

Figure 1 – Self-disclosure in AR (created using DALL-E).

2. LITERATURE REVIEW

2.1. Self-Disclosure

Self-disclosure (SD) is typically defined as revealing personal information from one person to at least another [14]. Before the Internet, SD mainly occurred among those who knew each other and usually within their community [1,11,27]. Since information revealed from SD is not easily accessed through any other means except the person disclosing the information, trust, defined as the willingness to take risks in a relationship [39], is a significant factor that affects how much a person is willing to disclose. Self-disclosure is essential in social network sites (SNSs) because it fulfills fundamental human needs for social connectedness and belonging; in SNSs, social disclosure occurs when users share personal details, including their moods, opinions, ideas, beliefs, and personal information.

2.1.1 Social Exchange Theory and Privacy Calculus

In social science, self-disclosure is viewed as a social exchange process in which individuals evaluate cost and benefit before communicating with others [7]. Based on this are the Social Exchange Theory (SET) and its extension - Privacy Calculus (PC), which are the most prominent theories in social disclosure research in social networks [1,27,45]. According to SET, social behavior results from an exchange process between actors, defining the costs as primarily alternative activities or opportunities foregone by the actors involved in the exchange. SET suggests that individuals are likely to engage in activities that foster relationships, such as self-disclosure, only if the perceived benefits of doing so are equal to or greater than the perceived costs [41]. PC extends SET. In PC, the exchange costs are privacy risks, encompassing concerns about losing control over one's personal information. These privacy concerns, representing an intrapersonal tradeoff, have been shown to significantly lower users' willingness to share personal information on SNS platforms due to fears of privacy loss [1,13].

2.1.2 The Privacy Paradox

A debatable issue persists within the dynamics of self-disclosure on SNSs — the privacy paradox [5]. This paradox illuminates a pronounced discrepancy between users' expressed privacy concerns and their actual behaviors regarding information disclosure. Despite an intention to

preserve privacy, the actions of users often narrate a contrasting story. A complex interplay of factors influences this inconsistency: users' perceived control over their information, their trust in the SNS provider, perceived benefits such as social connectivity or rewards, and the prevailing social norms. These elements collectively may drive users to disclose more personal information than originally planned [22].

Challenging the traditional perspective of the privacy paradox [40], researchers suggest that the observed discrepancies might not accurately reflect users' valuation of privacy. They propose that these differences arise from context-specific decisions about the risks of sharing personal information. This implies that the choice to share or withhold information goes beyond a simple desire for privacy and is molded by the distinct context in which users share data.

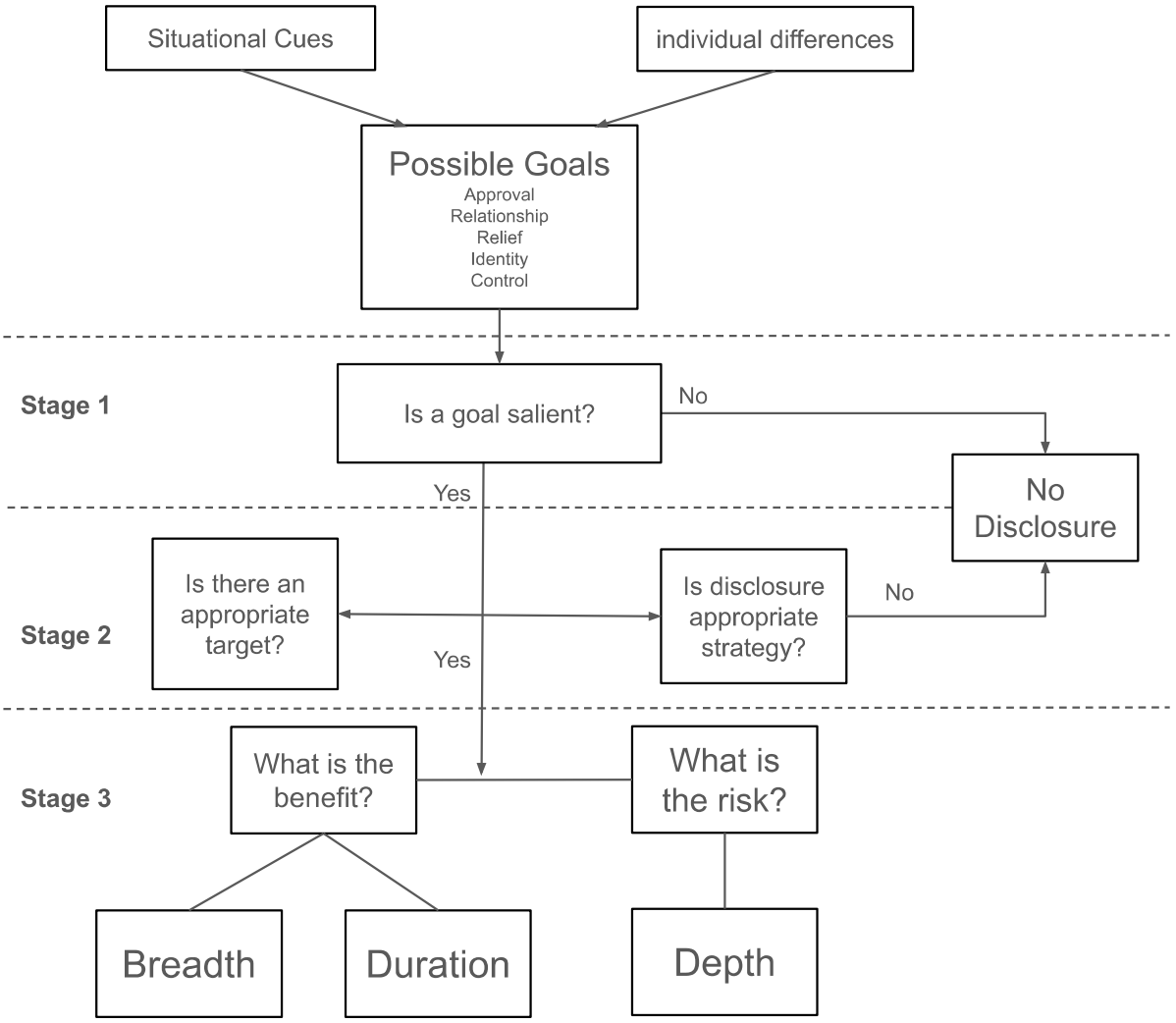
In response to this interpretation of the privacy paradox, studies advocate for a shift in regulatory focus. Rather than burdening privacy self-management on individuals — an approach often deemed impractical — they propose regulations that target the systems governing information use. The emphasis is on creating SNS designs that inherently prioritize user privacy, recognizing the complexities of user behavior in diverse contexts. This approach acknowledges that users' privacy needs can vary significantly depending on the situation, leading to a call for more context-aware and user-centric privacy protections in the design of SNSs [3,40]

2.1.3 The Disclosure Decision Model

The Disclosure Decision Model (DDM, figure 2) is a model that was developed by Omarzu et al [30]. It explains how and when individuals disclose information about themselves. The DDM divides the self-disclosure process into three stages. In the first stage, an individual enters a situation where a particular disclosure goal is made accessible. In the second stage, the individual decides whether disclosure is an appropriate strategy. In the third and final stage of the DDM, the individual chooses what information to disclose, how much to disclose (the breadth), how intimately to disclose it (the depth), and the sheer amount of the disclosure (the duration). Like SET and PC theories, the decision is based on weighing the possible risks and benefits of the disclosure.

Building upon Omarzu et al. work, Bazarova and Choi [7] suggested a functional model of self-disclosure in SNSs based on Omarzu et al. DDM. Their research aimed to explore what motivates individuals to engage in self-disclosure on SNSs and how these disclosure goals impact the intimacy of the disclosure. Their study analyzed over a thousand messages from eighty-one participants on Facebook, posted on three different mediums: participants' walls, status updates, and private messages. They assigned one of seven possible goals to each message (each message disclosing personal information). These goals were categorized as: Identity clarification, Relationship development, social validation, social control, Self-expression, Information sharing to benefit others, and Information storage and entertainment. The first five categories were based on Omarzu et al. research, while the last two came up specifically in the study. Their research concludes that self-disclosure motivations and characteristics on social media vary based on media affordances like visibility and directedness. It finds that people pursue different strategic goals in various Facebook communication forms (status updates, wall posts, private messages), with these forms influencing disclosure intimacy. It reveals that strategic goals drive self-disclosure on social media and that the nature of the medium influences how intimately people disclose information.

Figure 2 - The DDM adapted from Omarzu et al. work [30]



2.1.4 Self-disclosure reciprocity

Self-disclosure reciprocity, a dynamic and bidirectional process, is essential for sustaining relationships [46]. It involves the mutual revelation of personal information that is matched in intimacy and detail, responding to another's disclosure [17]. This process becomes particularly critical in the realm of online interpersonal dynamics. Within this domain, turn-taking reciprocity — where a person's disclosure quickly elicits a related response from another — is a key component. This immediate and synchronous exchange can substantially enhance positive social outcomes, effectively building interpersonal trust and fostering liking among strangers in online settings [12].

2.1.5 Awareness of Privacy Risks of Self-disclosure

Users are aware of privacy risks in SNS [21,28], and awareness has heightened with stories like the Facebook-Cambridge Analytica scandal gaining public attention [20]. The Cambridge Analytica Scandal started in 2014 when Cambridge Analytica hired a data scientist who developed an application known as "thisisyourdigitallife," in which approximately 270,000 people were paid to disclose psychological information using a quiz. The app then used a security hole in Facebook to harvest data from their quiz users' friends, such as where the users lived and what pages they liked. The data was used to create a psychographic, a methodology used to analyze the attitudes and interests of the users. The Cambridge Analytica Scandal was the most significant data leak in Facebook history, with over 87 million users' data leaked. The story gained media attention, which increased awareness of their privacy and what they self-disclose on these networks among Facebook and SNS users. Facebook was fined a massive 5 billion dollars fine for its involvement in the scandal [31,52]

Another example of risks of users' SD on SNS was in 2009 when insurance companies stopped paying depressed women after finding pictures that the women shared on social networks in which they seemed happy [53]. An additional risk that SNS SD raises is the danger of identity theft. Identity theft occurs when someone uses another person's information to impersonate that person to achieve some goal. Hackers use pictures and information posted on SNS to commit identity theft [2,54].

Despite the risks associated with self-disclosure on social networking sites, users frequently choose to share personal information. For instance, one study [24] highlights this propensity, revealing that over 88% of Facebook users openly share details such as their birthdays. The same research also finds that a majority disclose their political views and other interests, underlining a common tendency towards transparency on these platforms. To promote SD, social networks such as Facebook offer users an array of possibilities to share personal information, starting from the onboarding registration page. SNSs like Facebook allow users to control who can access their personal information. These controls are used to mitigate costs associated with privacy costs and to increase user trust [1]. However, often, it is difficult to understand and control these settings.

2.2. Augmented Reality

The concept of Augmented Reality was first established by Ivan Sutherland in 1965 in a renowned essay titled "The Ultimate Display," who used it to construct head-mounted display systems [42]. Augmented Reality is defined as a medium in which digital information is overlaid on the physical world [34]; Azuma provides three widely used criteria for AR systems [37]:

Combines virtual and real: AR requires display technology that allows users to see virtual and accurate information in a combined view simultaneously.

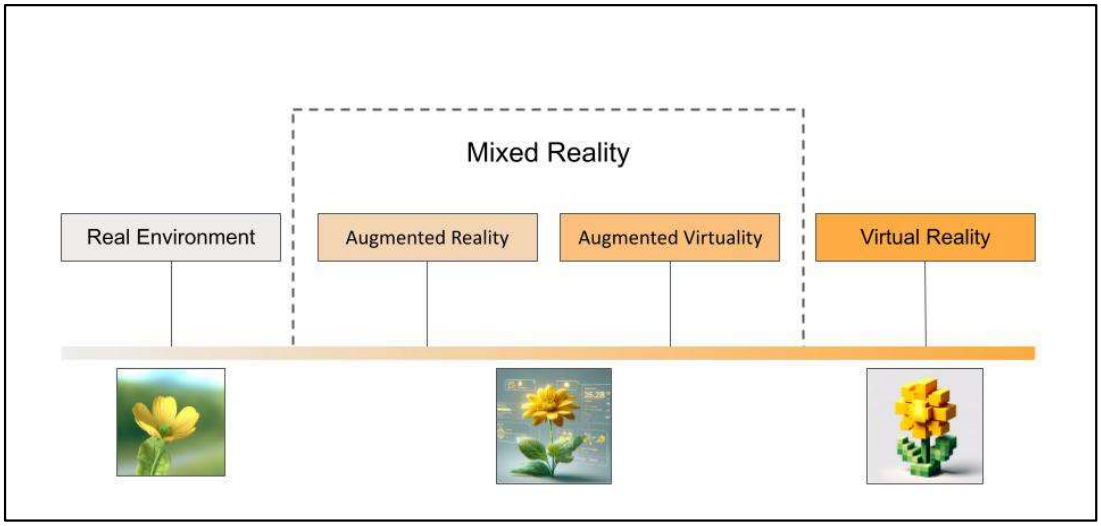
Registered in 3-D: AR relies on an intimate coupling between the virtual and the objective based on their geometrical relationship, which makes it possible to render the virtual content with the proper placement and 3D perspective for the real.

Interactive in real-time: The AR system must run at interactive frame rates to superimpose information in real-time and allow user interaction.

Mixed Reality (MR) is defined by Milgram [26] as conceptualized within the framework of the reality-virtuality continuum (Figure 2). This continuum represents a scale that spans from real space on one end to virtual space on the other. MR is positioned between Augmented Reality and Augmented Virtuality (a concept where the primary experience is predominantly virtual but augmented with real elements). MR aims to blend real and virtual environments, allowing real and virtual objects to coexist and interact in real-time, catering to specific user scenarios. This integration of virtual and real objects creates a hybrid of the virtual and real worlds, thereby

embodying the essence of MR as a class of simulators that merge these two realms. In Milgram's continuum, AR is positioned towards the real environment end but not at the extreme. It involves the augmentation of the real world with virtual objects. Unlike environments that are solely real or solely virtual, AR represents a blend where real-world views are enhanced or augmented with computer-generated images. Thus, in the continuum, AR falls between the real environment and the central point of the continuum, where a perfect blend of real and virtual elements exists [36]

Figure 3 - Milgram's reality-virtuality continuum [26]



In the reality-virtuality continuum, the left end represents the real environment, as if it was experienced directly through a window. The right end signifies an entirely virtual environment devoid of real-world elements. Between these lies mixed reality, incorporating both real and virtual aspects [26]

2.2.1 AR Technologies:

There are three types of augmented reality displays:

1. Direct projection: AR can be achieved by directly projecting graphics onto the real environment. The advantage of direct projection is that the virtual object is directly added to the real environment, can be seen by anyone in the area, and is more likely to be perceived naturally by the users [38].

2. Head-mounted display (HMDs): HMDs can use video or optical see-through techniques by placing the display close to the eye; thus, the AR is projected directly to the users. Advantages of

this option include personal AR (each user in the area can see something different) and a sense of immersion in the environment [33,38].

3. Handheld devices: the augmented information is shown on a handheld device on top of the video seen through the camera. The recent surge in popularity of AR through handheld devices, such as mobile phones and tablets, exemplified by games like "Pokémon Go," is largely due to their widespread availability and user familiarity with these devices [34].

2.2.2 Augmented Reality and Smart Glasses

Augmented reality smart glasses (ARSGs) are HMDs in the form of glasses with screens that merge virtual and real-world visuals in the user's view. They come in two types [44]. One type is video see-through glasses [25], like Oculus[1] and Apple Vision Pro[2], which use cameras to capture external scenes and display them with digital imagery on internal screens for an immersive experience. The real world is viewed via video, allowing deep integration of virtual and real elements in a large field of view. The other type of ARSG is Optical See-Through Smart Glasses, exemplified by HoloLens[3], which feature transparent lenses, letting users see the real environment directly [5]. Digital content is projected onto these lenses, overlaying virtual elements naturally onto the real world. This type offers a more realistic interaction with the physical environment, though less immersive than video see-through glasses, as they typically have a smaller field of view [19]. The acceptance of ARSGs is notably challenged by their incompatibility with current social standards, especially regarding fashion and privacy.

Privacy concerns are heightened due to the ease of recording images with these devices, raising unauthorized surveillance or recording issues. While some users value smart glasses for their rarity and alignment with the trend of wearable devices, there is an intense desire for these glasses to meet conventional fashion standards, reflecting an underlying wish for them to be less intrusive and more socially acceptable [23]

[1] https://www.meta.com/quest/quest-pro/tech-specs/
[2] https://www.apple.com/apple-vision-pro/specs/
[3] https://learn.microsoft.com/en-us/hololens/hololens2-hardware

2.2.3 Users' Self-Disclosure within Augmented Reality Environment

In a study [16] investigating bystanders' privacy concerns around AR devices, the authors conducted field sessions in cafés and interviewed 31 bystanders about their reactions to AR devices. The study's findings indicate an impact of AR devices on public behavior and self-disclosure. Participants' reactions were primarily split between indifference and negativity towards the presence of an AR device. Those who felt that AR devices altered the bystander experience cited factors such as the subtlety and ease of recording and the technology's relatively low prevalence in daily life. This awareness could change how individuals present themselves publicly, potentially affecting their willingness to disclose personal information. Concerns about being recorded without consent were prevalent, with participants expressing a desire for more control over their privacy, either through being asked for permission before being recorded or through recording-blocking devices. These insights underline the importance of privacy and consent in designing AR technologies and the broader implications for social interaction and self-disclosure in public spaces.

A recent paper [35] investigated how disclosing personal information in AR impacts user comfort. The study focused on how comfort is influenced by the medium (AR vs. smartphone), the viewer's role (either as 'receivers'—those being observed, or 'perceivers'—observers of the information), and the nature of the information (self-disclosed vs. non-self-disclosed, and level of intimacy). One hundred forty-eight participants were recruited through a crowdsourcing platform and introduced to AR technologies via textual explanations and videos. Comfort was assessed using a 7-point scale, capturing the personal impact of AR technology. The study revealed that AR led to lower comfort levels than smartphones, attributed to AR's more invasive nature and immediate display of personal information. This contrasted with the more controlled and familiar interface of smartphones. Secondly, participants experienced significantly lower comfort levels when in the role of receivers than perceivers, highlighting the sensitivity around privacy when one is the subject of observation. Furthermore, the study uncovered that in AR, the intimacy level of the information and the knowledge of consented information sharing had a lesser impact on comfort than in smartphone use. This diminished impact in AR is primarily due to its immersive characteristics, lack of anonymity, and potential for direct eye contact, collectively contributing

to a generalized discomfort. These findings underscore that in AR environments, the medium's intrusiveness and the nature of user interaction overshadow factors like information intimacy or consent awareness. The study concludes that in AR, the way information is presented, and interpersonal dynamics are crucial in shaping disclosure, more so than the specific content or knowledge about consent.

In conclusion, while the majority of self-disclosure research has concentrated on online social networks, the exploration within augmented reality is notably sparse. Our study seeks to fill this void by providing an in-depth examination of self-disclosure within AR's different contexts. We focus on delineating the specific goals that prompt users to disclose personal information, the benefits they aim to secure through such disclosures, and the level of control over the information they desire. Additionally, we assess the risks that accompany self-disclosure in AR—an area that remains largely uncharted in existing studies. To gain a comprehensive understanding of these components, we utilized exploratory interviews as the primary methodology. This approach utilizes qualitative methodology to directly engage with participants' thoughts and perspectives, allowing for an exploration of both the contextual and internal drivers that impact self-disclosure in AR environments. Our study fills the current knowledge gap and adds to the discourse on how users disclose personal information in the context of AR, providing an understanding that is vital for the development of AR social networks.

3. METHODOLOGY

To address the gap mentioned in the previous chapter, we conducted a user study to investigate self-disclosure dynamics in augmented reality in various social settings. Participants were first introduced to AR technology to ensure a clear understanding of its capabilities and implications. They then completed an online survey to capture their initial thoughts and inclinations toward self-disclosure in three different AR social settings. Lastly, we conducted exploratory interviews to gain deeper insights into the nuances of their decision-making process and the factors influencing their willingness to share personal information.

3.1 Study Context: "Augmented Reality Social Networks"

We used the term "Augmented Reality Social Networks" to connect the concept to the familiar realm of traditional social networks. This helps participants understand that while the technology is new—blending digital and physical worlds—the core principles of sharing, interacting, and networking remain unchanged. This terminology makes the concept of disclosing information in augmented reality more accessible and relatable, ensuring participants can easily see it as an extension of the digital interactions they already know.

3.2 Research Questions

The following research questions guided our study:

- **RQ1:** What motivates users to self-disclose in augmented reality social networks?
- **RQ2:** What risks do users perceive in self-disclosure within augmented reality social networks?
- **RQ3:** How do the drivers of self-disclosure identified in RQ1&2 influence user behavior across different contexts in augmented reality social networks?

3.3 Participants

Recruitment for the study was achieved through the use of paper advertisements on the university campus and posts within various Facebook groups. This approach successfully enrolled 15 participants. Given the exploratory nature of the research, this sample size was deemed appropriate. It allowed for a rich and detailed exploration of individual experiences. The study encompassed a diverse age range with participants between 25 to 63 years old. The demographic spread included six females and nine males, with ten in a relationship or married, while five were single. This resulted in an average age of 36.2 years, with a standard deviation of approximately 9.8 years, ensuring a broad spectrum of life experiences to inform the study's insights.

3.4 Scenarios

The participants were presented with three different scenarios: "The Pub," "The Conference," and "The Campus.". We chose each scenario to represent a different environment in terms of size (small, large, and medium), context (leisure, professional, semi-professional), and openness (fully open, closed, semi-open).

At the beginning of each page of the survey, we introduced the scenarios with the following descriptions:

3.4.1 The Pub:

“You and your friends went to a bar in the evening; before entering the pub, you were asked if you would like to join an AR network in the pub. If you choose to join, you will be given AR glasses to scan other participants in the pub. You will be asked to fill out a form using your smartphone to disclose information about yourself that the other participants in the network could see”.

3.4.2 The Conference:

“You have been invited to a private conference about your job or field of study. Upon entering the conference, you are asked to join an AR network. If you choose to join, you will be given AR glasses that can scan other participants in the conference and see information on these participants. You will be asked to fill out a form using your smartphone in which you will disclose information about yourself that the other participants in the network could see.

3.4.3 The Campus:

“You are a student at a university. You are asked to join an AR network. If you choose to join, you will be given AR glasses that can scan other participants on the campus, and you will be asked to fill out a form using your smartphone in which you will disclose information about yourself”.

3.5 Study Design

Before the meeting, participants were asked to complete an online form with basic demographic information. We used this information to create an AR demo. The demo was created using Meta Spark Studio. The demo was shown to participants to introduce them to AR and demonstrate how disclosing AR information might look by showing them on a screen how the information they disclosed would look in AR (Figure 3). After the demo, we asked participants to complete a survey using the computer; the survey was presented on a webpage. Each page in the survey started with a one-paragraph description of each scenario. Initially, the participants were asked if they would be interested in participating in an Augmented Reality (AR) social network under the current scenario. Even if they answered "no," they were instructed to complete the rest of the survey. Subsequently, the participants were presented with a pre-made list of information (Table 1). These information types were chosen because they have been examined in previous studies within the field of self-disclosure on social networking sites, which test their prevalence and patterns of sharing [35]. Participants were asked to choose which information they would be willing to disclose by choosing yes or no to each given option.

After the survey, we conducted a semi-structured exploratory interview with each participant. First, participants were again explained the scenarios. Then we asked about each scenario, how they felt about disclosing information, whether they found disclosing and receiving information useful, and how it compared to the other scenarios.

Then, we asked the participants whether they would prefer control over who sees their disclosure and if they would like to condition disclosure on mutual exposure. Toward the end of the interview, we asked more general questions about their feelings regarding disclosing information in AR. *The full interview script is provided in Appendix A.*

Figure 4 - Demo that was shown to the participants.

Table 1 –information details in the survey

Category	**Information**
Personal Identifiers	First Name, Last Name
Contact Details	Email Address, Phone Number
Demographic Information	Country of Residence, Date of Birth
Professional Data	Workplace, Job Title, Employment Status
Personal Information	Marital Status, Sexual Orientation
Interests	Hobbies, Favorite Movie

3.6 Analysis

We applied the thematic analysis procedure as outlined by [10]. Our process began with the transcription of interviews, which were then imported into the Atlas.ti software to aid in systematic analysis. Through an iterative reading process, we familiarized ourselves with the depth of the data, preparing for the subsequent coding stages. Adopting a hybrid coding approach, we combined top-down and bottom-up methods to explore themes comprehensively. This process involved an iterative coding analysis conducted by a single researcher, with each stage carefully reviewed in discussions among the research team. Codes were refined until a unanimous agreement was achieved, ensuring the study's analytical robustness. Drawing on established frameworks [7,30] while remaining open to emergent data themes, we identified users' self-disclosure goals in AR, along with the perceived benefits and risks, reflecting a dynamic coding process.

The interview and survey were conducted in Hebrew. As such, the quotes used in this paper were translated from Hebrew to English by a researcher proficient in both languages. This ensures that the quotes' accuracy and integrity are maintained in the English version presented in this paper.

4. FINDINGS

After completing the analysis outlined in the methodology chapter, we will now present the results derived from the analysis. We begin by examining the general inclination of people towards joining an AR-based social network, as highlighted in our survey, where participants responded to scenarios in three different settings. Following this, we explore self-disclosure goals in AR environments, focusing on identity clarification, relationship development, and social control. In addition, we analyze the potential benefits and risks of disclosing personal information in AR. Finally, we discuss the concept of disclosure control and disclosure reciprocity, looking into how individuals might prefer to manage their personal information using AR social networks.

4.1 Willingness to Join an AR-based Social Network

For every scenario, we asked participants, “Would you be willing actually to join an AR-based social network in this scenario? Most participants (10/15) answered they would be willing to join such a network in all three scenarios. P1, P4, and P5 consistently answered “no” in all three scenarios, and P10 and P13 answered “no” only in the pub scenario.

When asked to elaborate, P1 stated: “Firstly, I believe in the importance of personal communication. Secondly, I am a private person who likes to keep my details until I need to disclose them for something specific”. P4 and P5 described themselves as private people who do not want to disclose information to strangers. As P4 said, "I believe that it is important to maintain a certain level of privacy when interacting with strangers. Therefore, I tend to reveal as little personal information as possible". P5 said, “I do not like to reveal personal information about myself. I need to maintain my privacy.”

Looking at the pub scenario, P10 Explained she would not like to join such a network, stating: "At the pub, my personal information was not necessary for anyone other than my friends who already know me." She did mention that she would join if her goal in the pub was to “find a date.”. Similarly, P13 expressed that she would feel vulnerable and exposed if she disclosed personal information at a pub. She believed that sharing such details would be an invasion of her privacy. However, she later stated that her decision would depend on the purpose and social setting. For instance, she would consider joining the network if it was a small and exclusive dating party.

4.2 What information are people willing to disclose

In the survey, we included a list of different types of information that participants were asked to say whether they would agree to disclose in the three scenarios. Table 1 displays the information that participants had the option to disclose.

For each scenario, we asked the participants to fill out a survey consisting of 13 yes or no questions regarding the information the participant would be willing to share, giving us a total of 195 answers for each scenario.

Table 2 shows the overall information users reported they would be willing to share according to each of the scenarios. We can see that the breadth, or the amount of information shared, varied among the different social scenarios, in line with the Disclosure Decision Model (DDM). The DDM suggests that this variation can be attributed to the differing perceptions of risks and benefits in each setting. Table 3 shows the specific type of information users were willing to share across scenarios. Interestingly, sexual orientation, a highly intimate detail, was shared by most individuals in the pub scenario but only by a few in the conference, despite the pub being perceived as having higher social risks. This observation contradicts the DDM's assertion that higher risks lead to less intimate information being disclosed. A potential explanation for this phenomenon could lie in the Privacy Paradox theory, which posits that despite understanding potential risks, the immediate social context and potential for personal connections can influence users to share more intimate details. This highlights the significance of context in self-disclosure within AR environments, suggesting that the situational factors in AR may have a more pronounced effect on disclosure behaviors than traditional risk-benefit analyses.

Table 2 – Overall answers for disclosing information questions in the survey in each scenario.

	Pub	**Conference**	**Campus**
Yes	99 / 50.8%	129 / 66.2%	104 / 53.3%
No	96 / 49.2%	66 / 33.8%	91 / 46.7%

Table 3 - Disclosed information in each scenario.

	First Name	Last Name	Email	Phone	Country	Birthday	Workplace	Hobbies	Favorite Movie	Job Title	Employment Status	Marital Status	Sexual Orientation
Pub	80%	27%	7%	7%	67%	47%	33%	67%	73%	33%	60%	80%	80%
Conference	87%	80%	73%	40%	93%	67%	80%	53%	40%	87%	93%	53%	13%
Campus	87%	40%	40%	7%	87%	60%	53%	73%	60%	47%	53%	60%	27%

4.2 User goals for disclosing information

In this section, we explore the goals for disclosure within the context of AR social networks. 'Goals for disclosure' refer to the underlying motivations that drive individuals to share personal information in these networks. These goals are pivotal in shaping the nature and extent of information users are willing to disclose.

Our interviews and analysis identified three prominent goals in users' decision-making when engaging with AR social networks using a deductive-inductive coding method. These goals include identity clarification, relationship development, social control and resource gain. These findings align with three of the five goals described in Omarzu's research [30] on disclosure decision-making [30]

1. **Identity Clarification** involves conveying information about oneself to help others understand how to interact appropriately. This goal is about self-expression and ensuring that others perceive one accurately. For instance, participants felt it was meaningful to disclose relevant information, such as age and marital status, to guide the social interactions. P2 highlighted this by stating, ‘I felt it was meaningful to disclose relevant information so the person in front of me would know my status and how to conduct themselves appropriately.’ This goal extends beyond basic demographic information to include sharing personal interests or hobbies, which can help find common ground with others. For example, P9 mentioned, ‘I would share my favorite movie because it can arouse interest in people. Someone might think, 'Wow, she likes this movie; I like it too'.‘
2. **Relationship Development** is centered on forming new relationships or maintaining existing ones. The nature of these relationships varies according to the scenario. In the conference setting, the focus is work-related, where participants like P15 aim to 'disclose information to connect with people I have a common interest with or if we share a goal to work on a project, or to meet people as colleagues, work partners, not for friendships.' In contrast, the campus environment emphasizes friendships, with participants seeking connections based on shared personal interests or experiences. P7's statement, 'I would like to get to know people who are somewhat relevant, let us say he is studying the history of this and that, and I will say I am studying the history related to this, so we have a reason

to connect,' reflects this desire for personal connection. In the pub setting, relationship development goals were divided between friendships and romantic interests. The overarching goal of relationship development, whether for professional networking, forming friendships, or pursuing romantic interests, reflects a pursuit of meaningful connections.

3. **Social Control and Resource Gain** involve strategically using self-disclosure to acquire resources or influence social outcomes. For example, P14, a business owner, highlights this strategic approach: 'As a business owner, I want to tell people who I am and what I do.' This statement shows how disclosure can serve as a tool for professional advancement and brand promotion. Similarly, P9, who works as a lab assistant, suggests that disclosure in AR could be used to foster a competitive environment, particularly in professional settings like conferences. She posits, 'Disclosure in AR could be used to create competition between colleagues in the conference to see who recruits the most patients for a clinical trial.' Those examples highlight how strategic disclosure can extend beyond personal promotion to influencing social dynamics and outcomes in a professional context.

Table 4 shows the different goals and the distribution of participants' goals according to the scenario. We can see that the overall goals of self-disclosure are relatively similar in all three scenarios, with identity clarification being the most prominent, followed by relationship development. Social control was also an essential goal despite its relatively small size.

Table 4 - Total number and percentages of goals by scenario

Goal	Explanation	Example	N / % Overall	N / % Pub	N / % Conference	N / % Campus
Identity clarification	To convey one's identity	" I would disclose if I were married...I wouldn't want someone to hit on me."	36 / 53.7%	14 / 60.8%	18 / 51.4%	4 / 44.4%
Relationship development	To manage and maintain a relationship	"To make friends with students who are in the same class as me."	26 / 38.8%	8 / 34.7%	13 / 37.1%	5 / 55.5%
Social control	To obtain benefits or information from others	"I can use it to publish my business."	5 / 7.5%	1 / 4.3%	4 / 11.4%	0

4.3 Benefits gained from disclosing information

A benefit is a potential reward for disclosing information, distinct from a goal, which is the underlying motivation for sharing. Goals are the 'why' behind disclosure, and benefits are the 'what' one hopes to gain from achieving these goals. For instance, if the goal is to build a new romantic relationship, a benefit could be the deepening of that relationship through targeted and meaningful disclosure.

According to the SET and PC theories [15,45], individuals weigh the benefits and risks before disclosing. Moreover, according to Omarzu [30], who refers to benefits as 'subjective utilities,' the benefits dictate the breadth of information disclosed. As the potential rewards for disclosing increase, individuals tend to become more strategic in their communication, focusing more on topics most relevant to achieving their goals. This strategic approach allows for more efficient and effective communication, ensuring that the information shared is directly aligned with the desired outcomes. Individuals may derive multiple benefits from disclosing information, and these benefits are not limited to a single outcome. Notably, the benefits of sharing personal details, such as sharing contact information for future communications, informed interactions that enable more meaningful conversations, targeted communication that serves specific social or professional aims, and expressing shared values and interests to attract like-minded individuals, can overlap within a single exchange. These concurrent benefits can exist within any given context—be it a pub, conference, or campus setting—thereby influencing both the nature and extent of the information participants choose to share.

Based on our analysis of the interviews, we have identified four types of benefits of an AR-based social network:

1. **Sharing Contact Information:** Involves disclosing personal identifiers, like one's name and contact details, to facilitate future communication outside the immediate social setting. For instance, P10 said regarding the conference scenario, 'If I reveal my name and email, someone relevant can contact me later via the Internet.' .By sharing such details, individuals lay the groundwork for continued communication, allowing relationships or collaborations to develop beyond the initial encounter

2. **Informed Interaction:** This benefit involves sharing background information to enable informed and contextually relevant interactions. For example, P12 said: 'The fact that you have all the details in front of you makes it easier to start a conversation, knowing what to talk about in general'. Such disclosure ensures that conversations are more accessible to initiate and more likely to be engaging and pertinent to both parties involved. It's about crafting comfortable and productive interactions, leveraging the power of shared knowledge to create a connection.
3. **Targeted Communication:** This benefit involves strategically disclosing information to identify and engage with the most appropriate individuals. For instance, in the Pub scenario, participants might disclose their marital status to guide social interactions to their advantage. By doing so, they can attract the right kind of attention or deter unwanted approaches, effectively managing their social interactions. This targeted approach serves the discloser by helping them navigate social settings more effectively and align interactions with their personal preferences or goals.
4. **Shared Values and Interests:** This benefit involves disclosing one's values and interests to attract individuals with similar perspectives and passions. The focus here is on sharing aspects of oneself to naturally draw like-minded people, whether for romantic connections, friendships, or professional relationships. By revealing personal values and interests, individuals can facilitate the formation of connections more aligned with their identity and goals.

Table 5 illustrates the distribution of perceived benefits across different scenarios, offering insight into the significant impact of context on the anticipated benefits of self-disclosure. In the conference scenario, various benefits were sought, corresponding with a broader range of information shared, as indicated by Table 2 and Table 3. Participants in professional settings appeared motivated by diverse advantages, from networking for career opportunities to engaging in informed interactions, targeting specific professional groups, and connecting over shared professional. This multitude of benefits may lead to an increased breadth of disclosed information, as seen in Table 2, which is consistent with the DDM's notion that the perception of varied benefits can broaden the scope of disclosure.

In the more informal setting of the pub, Targeted Communication was especially prominent, reflecting a focus on direct and immediate social or romantic connections. Meanwhile, the campus environment's emphasis on shared values and interests suggests a propensity for building relationships based on commonalities in a collaborative, community-oriented setting. These trends highlight that the primary benefits participants seek from self-disclosure are inextricably linked to the dynamics of the scenario—where a professional conference encourages a wide-ranging exchange of information across various facets, a social setting like a pub fosters more targeted, immediate exchanges and an academic setting like a campus nurtures shared interests and longer-term relational ties.

Table 5 – Benefits in each scenario

Benefit	Pub	Conference	Campus
Sharing Contact Info	2 / 4.8%	8 / 19%	0
Informed Interaction	12 / 28.6%	10 / 23.9	0
Targeted Communication	20 / 47.7%	14 / 33.3%	4 / 28.6%
Shared Values and Interests	8 / 19%	10 / 23.9%	10 / 71.4%

4.4 Risks

Risk refers to the possibility of negative consequences resulting from the self-disclosure of personal information. SET, PC, and The DDM assume that individuals evaluate not only the benefits of disclosure but also its potential risks. Moreover, according to the DDM the risks affect the level of intimacy of the information (the depth). Using an inductive-deductive approach, our analysis of the interviews led us to identify six types of risks associated with self-disclosure in AR.

1. **Fear of Prejudgment:** This risk involves being prematurely judged based on the information disclosed. Table 6 shows this was a prevalent concern among participants across the different scenarios. In social settings like the pub, revealing personal details such as one's employment status or age could lead to immediate judgment and affect social interactions. As P12 said, 'In the pub if you reveal you are unemployed or your age, some might outright avoid talking to you based on these details alone'. Primarily, the fear of prejudgment extends to more sensitive information. For instance, P14 expressed concern about the disclosure of sexual orientation affecting academic judgment, stating, 'A lecturer might change their perception and even grading decisions upon discovering my sexual orientation'.
2. **Inappropriate Disclosure:** This risk pertains to the discomfort caused to the receiver by disclosing information that is deemed inappropriate or controversial for the context. This was a significant concern in the conference scenario, as illustrated in Table 6. In the conference, participants were particularly cautious about discussing their sexual orientation. P6 exemplified this caution by saying, 'I would not reveal my sexual orientation at the conference because it is not relevant; you are not supposed to be interested in sexual orientation at a professional conference'.
3. **Information Getting to Unintended Places:** This risk pertains to the possibility of disclosed information reaching unintended recipients, including commercial entities or criminal databases. Such unintended dissemination can lead to privacy breaches and misuse of personal data. P14's concern encapsulates this risk: 'I am afraid of someone sitting in the pub and systematically collecting information to transfer it to somewhere else'.

4. **Potential for Harassment:** This risk entails the potential for experiencing harassment, either immediately or in the future. This concern is distinct from worries related to spam and other forms of marketing and advertising, which we have categorized separately. This risk was closely associated with participants' reluctance to disclose their phone numbers, as they expressed concerns about receiving unsolicited contact from strangers. For example, P12 said, “I don't want to share my number with anyone because it can be used by stalkers who can harass you, like send you messages while you don't want any contact with them. I prefer to have a personal choice with whom to share my phone number … if I want someone to know my phone number, I'll give it personally”. Other participants mentioned that they were afraid that information disclosed would be used to hurt them, which P10 summarised as “someone might use it to hurt me or insult me”.
5. **Concerns Regarding Spam:** This risk pertains to the possibility of personal information being exploited by commercial entities to send spam and unsolicited advertisements. While overlapping with the risks of 'Information Getting to Unintended Places' and 'Potential for Harassment,' this concern focuses on the commercial misuse of disclosed information.
6. **Reduced Emotional Connection:** This risk involves concerns that sharing personal information through AR platforms might decrease emotional depth and genuine communication. Participants preferred more direct and personal interactions, fearing that over-reliance on digitally mediated information sharing could reduce the quality of their emotional connections. They highlighted the importance of face-to-face conversations in building meaningful relationships. As P1 articulated, ‘I am a communicative person; if I want to know any information about a person, I prefer to engage directly in conversation with them’.

Table 6 shows that the Pub scenario had the most risks mentioned, followed by the Conference and then the Campus. We can see that the risks highly differ across the different scenarios, indicating that the risks are context-dependent. There were also 17 times when risks were mentioned more generally unrelated to a specific scenario.

Table 6 - The type of risks reported by participants in each scenario

Risk	N / % Pub	N / % Conference	N / % Campus
Fear of Prejudgment	5 / 17.2%	4 / 17.4%	5 / 33.3%
Inappropriate Disclosure	1 / 3.4%	12 / 52.2%	4 / 26.7%
Information Getting to Unintended Places	2 / 6.9%	3 /13%	3 / 20%
Potential for Harassment	11 / 37.9%	1 / 4.3%	3 / 20%
Concerns Regarding Spam	8 / 27.6%	1 / 4.3%	0
Reduced Emotional Connection	2 / 6.9%	2 / 8.7%	0
All Risks	29	23	15

4.5 Disclosure Control

As part of the interview, we asked participants how they could have more control over what they disclosed.

Twelve out of fifteen participants indicated that they were interested in more control and that it would lead to them disclosing more information. Participants indicated that they would like to be able to show different information to different people. The reason for wanting more control was geared toward reducing risks and emphasizing the benefits. For example, P3 mentioned that one of her goals on campus could be to develop romantic relationships, and to achieve this goal, she would want to share her sexual orientation but only with fellow students, since she did not want to risk an inappropriate disclosure to lecturers.

Regarding the three participants who responded "no" to having more control, P1 and P5 had a generally negative attitude toward self-disclosure in AR. They consistently chose "no" when asked whether they would join a social network based on AR. P5 even went so far as to say that having more control would have a negative effect as it reveals the reason behind his disclosures “I don’t want anyone to know what my goals are”. P11 said he would only want control of prior permission. As we can see, individuals who consider themselves private and who initially do not favor disclosure in AR social networks did not necessarily change their minds with increased control.

4.6 Disclosure Reciprocity

Disclosure reciprocity, also known as self-disclosure reciprocity, is the process of revealing personal information in response to the disclosure of another individual, with equal amounts of intimacy and detail [17,41]. We asked the participants whether they would be interested in disclosure reciprocity, whereby they could view information about others willing to disclose the same information and vice versa. For example, “You can only see someone else's first name if you reveal your first name, and they will only see your first name if they reveal their first name”. Eleven out of the fifteen participants said they would want the information disclosure to be mutual, and seven said they would disclose more under this condition.

When asked why they would want mutual disclosure, participants explained that they would feel more comfortable and that it would be “fairer” and “expected”. P7 said, "I think it's fair that if I share something with you and you express interest in seeing it, you should be willing to share something with me in return. A mutual disclosure will encourage me to share more".

In summary, our findings indicate that most participants were interested in having more control over who can see their personal information, which they believed might lead to increased sharing. This inclination might stem from the belief that greater control over personal information can effectively mitigate the risks associated with disclosure. Conversely, while mutual self-disclosure may contribute to building trust, it does not necessarily address these concerns directly. These tentative findings resonate with the Disclosure Decision Model's perspective that the likelihood of information sharing increases when individuals perceive they can effectively manage the associated risks. However, it is important to note that while our study suggests such a tendency, the evidence is not conclusive, and the results should be interpreted with caution. Further research could provide more definitive insights into whether users' desire for control over their information consistently takes precedence over the motivations for reciprocal sharing.

5. DISCUSSION

Previous research examined users' comfort when disclosing information in AR compared to smartphones [35] . Our study extends this work by taking a broader perspective on self-disclosure dynamics in AR in different social settings. To that end, we analyze the perceived benefits, risks, and goals associated with self-disclosure in AR and the influence of control over information on disclosure decisions in different contexts. This approach allows us to uncover the nature of self-disclosure behaviors and the unique considerations they necessitate in the context of AR.

Following an introduction to AR and an online survey, participants were interviewed to explore their thoughts and feelings about self-disclosure in AR. We inquired about their comfort levels, fears, and perceived usefulness of disclosing information in different social contexts. Participants were also questioned on their preferences for controlling the visibility of their disclosed information and the concept of mutual disclosure.

Our study results found that participants' willingness to disclose personal information varied considerably based on the setting. For instance, in the pub, participants were unexpectedly willing to share intimate details such as their sexual orientation, which seems paradoxical given the higher associated risks in this setting. This willingness to disclose does not align with the expectations of the DDM model [30], which anticipates that greater perceived risks would lead to less intimate disclosures. Yet, this behavior could be explained by the privacy paradox [6,22,40], where the lure of immediate social rewards encourages users to disclose more than they might in other circumstances, prioritizing current social engagement over privacy concerns. This variability in self-disclosure can also be interpreted through the lens of Nisenbaum's "Privacy as Contextual Integrity" [29] a theory that posits that privacy is not an absolute state but a reflection of appropriate information flow based on social contexts and norms. Nisenbaum argues that privacy breaches occur not necessarily from the revelation of information per se but from the transgression of these implicit norms. In our study, the differences in self-disclosure across settings might reflect the distinct norms governing what information is deemed appropriate to share within each social context. This suggests that participants are intuitively attuned to the contextual integrity of their information practices.

Those findings align with Rixen et al.'s study [35], which suggests that AR's unique situational context and the compelling drive for social interaction can indeed overshadow traditional concerns about the intimacy and privacy of information shared. This phenomenon emphasizes the complex nature of self-disclosure within AR environments and the powerful influence of context on user behavior.

Using a top-bottom approach, which allowed us to compare our results to prior research on self-disclosure in SNSs, our study identified similar goals, such as identity clarification, relational development, and social control. Notably, the goal of identity clarification emerged with significantly greater prominence in our AR context. This could be because AR integrates virtual information with the physical world, potentially making the implications of self-disclosure more immediate and tangible. However, our findings did not find several goals previously associated with SNSs, including social validation, self-expression, relief of distress, and sharing information for the benefit of others [7]. These discrepancies may be attributed to the unique affordances of AR, which create a context where utilitarian goals take precedence.

We employed a bottom-up approach specifically for uncovering the benefits and risks of self-disclosure in AR, recognizing that these elements are often unique, context-dependent, and particularly sensitive to the nuances of the medium. These include sharing contact information for future networking, informed interactions through background sharing, targeted communication to find individuals with common goals, and expressing shared interests to foster deeper connections. What unites these benefits is their role in enhancing the quality of social exchanges by making them more relevant, efficient, and meaningful.

The connection between the number of disclosed items and the perceived benefits suggests an intricate relationship partially aligned with the DDM. Our findings indicate that while the DDM posits a narrower disclosure with increased perceived benefits, the AR context reveals a more complex pattern. In settings like a conference, the range of benefits could lead to a broader disclosure, as the benefits here are numerous and not concentrated on a singular significant benefit. In contrast, pursuing a specific benefit, such as ”shared values and interests”, in a pub setting might result in a more focused and narrow disclosure. This indicates that the significance and variety of benefits can influence the breadth of information users share, suggesting a

nuanced departure from the DDM's original predictions and highlighting the importance of context in disclosure decisions within AR environments.

Our study identified six risk categories associated with self-disclosure in AR, which varied in distribution across the different scenarios. Participants expressed concerns about harassment based on their shared information, particularly in the pub scenario, which saw the highest incidence of such worries. They also feared the discomfort of revealing inappropriate information, a risk most prevalent in the conference scenario due to its professional context. Moreover, the potential for personal information to fall into the hands of unintended recipients, including spam companies, was a concern across all scenarios, implying privacy concerns.

Participants were apprehensive about the risk of real-life harassment, accentuated by AR's unique blend of digital and physical worlds. This concern was pronounced in the pub setting, reflecting its public and unrestrained nature. These findings underscore the importance of context in AR experiences (which will discussed further in the next section). In addition to these risks, our results highlight a specific concern related to the nature of interactions in AR: the risk of reduced emotional connection. Participants feared that an over-reliance on digitally mediated communication in AR might diminish the depth and authenticity of their interactions, indicating a potential loss in the quality of emotional connections.

These findings also point towards a deeper understanding — that the nature of self-disclosure risks in AR may differ fundamentally from those identified in traditional social networks, while traditional social network studies often center on the risks associated with the privacy of information [1], the risk profile emerging from our study is different. More risks identified in our study were tied to immediate social implications rather than solely to privacy. This divergence is crucial, revealing how the interactivity and immediacy inherent in AR platforms shift user concerns away from the privacy of data towards the immediate social impact of self-disclosure.

Participants emphasized the importance of controlling their personal information. Eleven participants reported that increased control might lead them to share more, which can be attributed to the perception that such control effectively minimizes the risks associated with disclosure. This preference for control was also considered important in disclosure reciprocity, where seven participants indicated a willingness to share more if reciprocity was guaranteed.

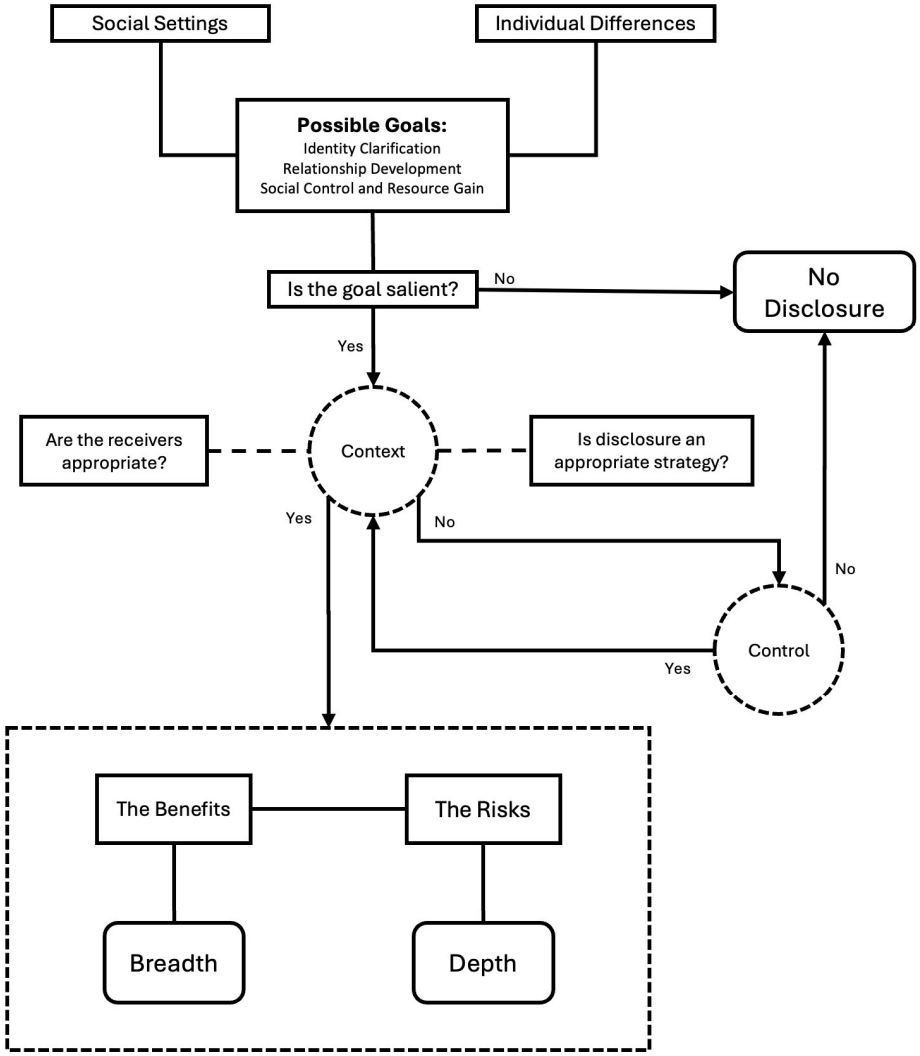
These findings resonate with the principles of the Disclosure Decision Model [30] and the Privacy Calculus theory, which propose that individuals carefully consider the risks and benefits before deciding to disclose information. The desire for more control aligns with these theories' emphasis on individuals' risk-benefit analysis, suggesting that greater control over one's information may lower perceived risks, potentially increasing their willingness to disclose information [24, 29].

5.1 Adaptation to the Disclosure Decision Model

Augmented reality presents a distinctive medium for self-disclosure, extending beyond the scope of traditional frameworks due to its unique affordances. Reflecting on our study's insights, we have nuanced the DDM to embrace AR's particularities (Figure 5).

The core principles of the DDM remain pertinent, with the benefits guiding the breadth of disclosure and the risks shaping its depth. However, a pivotal distinction in our adapted model is the role of context. In AR, context significantly influences both the benefits and risks of self-disclosure. This influence, in turn, directly impacts what information users choose to share and how deeply they share it. In this adaptation, the context is a dynamic element that permeates the decision to disclose. As AR integrates with users' physical surroundings, the context directly modifies the perceived benefits and risks, thus indirectly shaping the depth of disclosure. The control aspect also interplays with the context, allowing users to tailor their self-disclosure to their comfort levels and privacy preferences. This interconnection enhances the model’s intricacy, reflecting the multifaceted nature of self-disclosure in AR and providing a more comprehensive framework for understanding user behavior in this unique environment.

Figure 5 – Adaptation to the DDM for AR



5.2 Practical Implications

Our study revealed that the types of information users disclose and the risks they associate with such disclosures vary significantly across different AR social settings. Such variability accentuates the importance of context-aware privacy settings in AR social networking platforms, underlining a similar need identified in contemporary research [9]. Our findings suggest that users will prefer mechanisms that offer them enhanced control over their disclosed information, aiming to manage and minimize perceived risks effectively. Consequently, AR social networks should incorporate customizable privacy settings. These settings should be adjustable by users and capable of adapting automatically, providing prompts that alert users to potential risks or ensuring appropriateness in the given social context. For instance, in more formal settings, the system could recommend users be more conservative with what they share, while in a more social setting, it could allow for more openness but with clear prompts about the potential risks. By integrating these features, AR platforms can provide users with the desired control and foster trust, ultimately encouraging greater user engagement.

The study also underscores the importance of reciprocal disclosure in enhancing user trust and comfort within AR social networks. Our findings suggest that when users engage in reciprocal sharing of information, it fosters a sense of fairness and trust, corroborated by existing literature that identifies turn-taking reciprocity in self-disclosure as a contributor to positive interpersonal dynamics in computer-meditate communications [12]. In practical terms, this translates to the need for AR platforms to implement systems that promote and facilitate mutual disclosure. For example, features could be designed to ensure that a user's information is visible to another only if they have agreed to share a similar level of detail about themselves. This reciprocal exchange of information could enhance the overall user experience by creating a balanced and trustworthy digital space.

5.3 Limitations

There are several limitations in this study. First, it engaged with only fifteen participants, which may not fully represent the broader AR user base, potentially limiting the generalizability of the findings. Second, participants' limited familiarity with AR might have skewed their perceptions and interactions, as their understanding of AR's potential in everyday contexts may yet to be fully developed. Finally, we simulated an AR social situation asking participants to envision themselves in an AR environment, as opposed to interacting within an authentic AR social network. The abstraction from tangible experiences may not have accurately captured their true behaviors or responses. The absence of physical AR smart glasses further compounded this issue, precluding participants from engaging with a fully immersive AR experience.

5.4 Future Work

Future research should focus on refining context-aware privacy settings in AR social networks, examining how these settings should be defined and how they can function in real-world scenarios. Further work should immerse participants in situ by providing AR smart glasses setting and examining real-world social interactions. Assessing reactions to AR prompts about risks and norms in these natural settings would enhance the validity of findings. This research can evaluate how users interact with and act upon these system prompts, contributing to the design of context-aware privacy settings.

An essential aspect of these studies should include testing the effectiveness and user interaction with the system prompts themselves—how users present, perceive, and act upon them. Future research should also offer an opportunity to evaluate the principle of reciprocal disclosure by developing AR features that condition information visibility on mutual agreement to share similar personal details. Assessing the influence of such features on user trust and engagement could advance our understanding of relational dynamics and self-disclosure in AR.

6. CONCLUSION

Up to today, self-disclosure within technological environments mostly looked at online social networks. The current work is an innovative examination at what affects user's SD in AR social networks. We delved into self-disclosure dynamics across various AR social settings, revealing a complex, context-dependent nature. Our study identified the intricate interplay of user goals, benefits, desired level of disclosure control, and the risks associated with self-disclosure in AR environments.

A key finding is that the risks and benefits of self-disclosure vary significantly depending on the social setting, underscoring the importance of context in AR experiences. We also discovered that users value control over their information to mitigate perceived risks, and appreciate the benefits of reciprocal disclosure, which fosters trust and comfort. These insights emphasize the need for AR social networks to provide context-aware privacy settings, allowing users to manage their disclosures effectively, fostering a balanced, trustworthy digital space.

As AR continues to evolve and integrate into our social fabrics, these findings will shape user-centric and privacy-aware AR experiences. The insights from our study provide a foundation for future research and development in AR, guiding the creation of platforms that are not only technologically advanced but also attuned to users' social needs.

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Appendix A - Questionnaire for Participants

Questionnaire for participants (translated from Hebrew)

Hello, my name is Gal, and I am a master's degree student studying information systems at Haifa University. I would like you to share in an experiment that deals with revealing self-information in augmented reality. The experiment will last about an hour and will be divided into two parts; in the first part, a survey will be presented where you will be given three different scenarios, and after each scenario, you will be asked to answer a short questionnaire in which you indicate what information you would be willing to reveal about yourself in that scenario.
In the second part of the experiment, an interview will be conducted where you can explain your answer and your feelings during the experiment.
You will be asked for some demographic details, such as age, sex, family status, education, and occupation, at the end of the questionnaire.

Scenario 1:
You and your friends go to a pub in the evening. Before entering the pub, you will be asked to join a network based on augmented reality.
If you choose to join, you will be given augmented reality glasses to scan the other network participants in the pub. In addition, you will be asked to fill out a form using your smartphone, in which you can mark what information you would like to reveal about yourself, information that will be visible to the other participants.
* Clarification - anyone in the bar (including the employees) can be part of the network.

Scenario 2:
You have been invited to an international professional conference on behalf of your workplace. Before entering the conference, you will be asked to join an augmented reality network, if you are interested in it. If you choose to join, you will be given augmented reality glasses, with which you can scan the other network participants who are at the conference. In addition, you will be asked to fill out a questionnaire form using your smartphone, in which you can mark what information you would like to reveal about yourself, information that will be visible to the other participants.
* Clarification - anyone who attended the conference (including local employees) can be part of the network.

Scenario 3:

You are a university student, you have been asked to join a network based on augmented reality, if you are interested in it. If you choose to join, you will be given augmented reality glasses, with which you can scan the other network participants who are on campus. In addition, you will be asked to fill out a questionnaire form using your smartphone, in which you can mark what information you would like to reveal about yourself, information that will be visible to the other participants.
* Clarification - anyone on campus (including local employees and lecturers) can be part of the network.

At this stage, I will ask the participant to fill out the form
Please answer the questions in your own words:The following questions refer to your answers in scenario number 1 (the pub)
How did the disclosure make you feel?
What benefit (if any) would there be in disclosing information in this scenario?
What benefit (if any) would there be in getting information in this scenario?
What did you share in this scenario? Why?

The following questions refer to your answers in scenario number 2 (conference)
How did the disclosure make you feel?
What benefit (if any) would there be in disclosing information in this scenario?
What benefit (if any) would there be in getting information in this scenario?
What did you share in this scenario? Why? (ask about the differences)

The following questions refer to your answers in scenario number 3 (university)
How did the disclosure make you feel?
What benefit (if any) would there be in disclosing information in this scenario?
What benefit (if any) would there be in getting information in this scenario?
What did you share in this scenario? Why? (ask about the differences)

10. If you chose to share certain information in one or more scenarios, but not in another scenario, please explain why.
11. If you chose not to share information in any scenario, please explain why.

12. If you were given control over who can see the information (eg friends only), would you disclose different information? If so, explain why.
13. If you could see certain information about others, only if you revealed that information, how would it affect you?

13. The following questions refer to your use of social networks:
A. What social networks do you use?
B. When you publish information, do you usually limit the people who can be exposed to the publication?
third. Do you disclose different information on different social networks? If so, please explain why.

חשיפה עצמית במציאות רבודה

גל חדד

תקציר

טכנולוגיית המציאות הרבודה הינה טכנולוגיה אשר נמצאת בשלבי התפתחות מהירים, מאופיינת בשילוב של מציאות פיזית ודיגיטלית וביכולתה לשנות את הדרך שבה אנו מקיימים אינטראקציות חברתיות. בבסיס מחקר זה עומד הצורך ללמוד על הדינמיקה של "חשיפה עצמית" במציאות רבודה. המחקר נשען על תיאוריות כגון תאוריית החליפין החברתי, מחשבון הפרטיות ומודל ההחלטה של חשיפת המידע.

שאלות המחקר הן:

1) מה הם הגורמים אשר משפעים על משתמשים לחשוף מידע ברשתות חברתיות מבוססות מציאות רבודה?

2) מה הם הסיכונים שנתפסים ע"י המשתתפים בחשיפת מידע במציאות רבודה?

3) כיצד הסביבה וההקשר משפעים על "חשיפה עצמית" ברשתות מבוססות מציאות רבודה?

בשלב הראשון של הניסוי נבחנה באמצעות שאלון נטיית המשתתפים לשתף מידע בשלושה תרחישים חברתיים. התרחישים הובדלו בגודל, מידת הפתיחות וההקשר החברתי. לאחר מכן בוצע ראיון עם כל אחד מהמשתתפים. ניתוח הנתונים בוצע באמצעות ניתוח תוכן (Thematic Analysis).

ממצאי המחקר מעלים כי הגילוי העצמי במציאות רבודה מונע על ידי גורמים כגון מטרות אישיות, תועלות סובייקטיביות וסיכונים נתפסים, המושפעים מההקשר החברתי. שתי מטרות עיקריות שזוהו הינן "הבהרת זהות", שהייתה נפוצה יותר במציאות רבודה מאשר ברשתות חברתיות מקוונות, וכן "פיתוח מערכות יחסים". ממצאי המחקר מצביעים על כך שחשיפה עצמית במציאות רבודה מושפעת רבות מההקשר החברתי. ניתן להבין זאת, בין היתר, מהפיזור של הסיכונים הנתפסים, התועלות הסובייקטיביות וסוגי המידע בין התרחישים השונים אשר המשתתפים הסכימו לחשוף. לפיכך, המחקר קורא להטמעת מערכות פרטיות אשר יהיו מודעות להקשר החברתי ברשתות חברתיות מבוססות מציאות רבודה, מערכות אילו יביאו לשיפור האינטראקצי ה החברתית ויסייעו למשתמשים לחוש הרגשה של ביטחון ונוחות ברשתות חברתיות מבוססות מציאות רבודה.

חשיפה עצמית במציאות רבודה

מאת: גל חדד

בהנחיית: פרופסור יואל לניר
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