

Master Degree Project



UNIVERSITY
OF SKÖVDE

Exploring Individual Privacy Concerns in Mixed Reality Use Situations

A Qualitative Study

Master Degree Project in Informatics with a specialization in Privacy, Information and Cyber Security

Second Cycle 30 credits

Spring term 2024

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ACKNOWLEDGEMENTS

I want to extend my deepest gratitude to my supervisor, Martin Lundgren, for his unwavering support and invaluable guidance throughout this research. His expertise and insights have been pivotal in shaping this thesis. I am also immensely grateful to my examiner, Marcus Nohlberg, for his constructive feedback and encouragement.

Special thanks to all the participants who generously shared their time and experiences, providing the essential data that formed the backbone of this study. This research could not have been accomplished without their candid contributions.

I also appreciate the support from the University of Skövde, which provided the resources and environment necessary for my academic pursuits. My fellow students and colleagues deserve special mention for their camaraderie and stimulating discussions, which enriched my research experience.

Lastly, I thank my family and friends for their patience, understanding, and support during my academic journey, which has been both challenging and rewarding.

ABSTRACT

This Master's thesis explores the nuanced dimensions of privacy concerns in mixed reality (MR) environments. As MR technologies increasingly integrate into daily life, understanding how individuals perceive and navigate privacy within these contexts becomes crucial. This qualitative study employs semi-structured interviews to gather insights from users actively engaged with MR, aiming to identify key privacy issues and the impact of social interactions on privacy dynamics.

The research reveals that privacy concerns in MR are influenced by a complex interplay of technology features, user interactions, and contextual settings. Participants expressed apprehensions about data security, unauthorized information access, and a lack of control over personal data shared within MR environments. The findings highlight the need for enhanced privacy safeguards and transparent data management practices to foster trust and security in MR applications.

This study contributes to the growing discourse on privacy in immersive technologies by providing empirical evidence and proposing recommendations for designing privacy-aware MR systems. It aims to inform developers and policymakers in the development of robust privacy frameworks that align with user expectations and legal standards, thereby enhancing user engagement and trust in MR technology.

Keywords: Mixed Reality, Privacy Concerns, Qualitative Study, User Perceptions, Data Security, Technology Interaction.

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1. Introduction

In an era where digital technologies seamlessly blend with our physical environment, Mixed Reality (MR) emerges as a frontier pushing the boundaries of interaction by merging the real with the virtual (De Guzman et al., 2023). This integration offers profound opportunities for enhancing daily activities, educational experiences, and professional engagements. However, as the adoption of MR technologies accelerates, it becomes crucial to address the privacy concerns that arise within these blended environments (Thilakarathna et al., 2023).

Privacy in MR presents unique challenges. Unlike traditional digital interactions that allow a clear distinction between personal and public digital spaces, MR environments intertwine these spaces, creating complex privacy dynamics (Padyab & Ståhlbröst, 2018). Users in MR settings navigate a realm where digital content is overlaid on physical reality, potentially exposing personal data and behaviors to new forms of surveillance and data collection. This raises significant concerns about who can access this data, how it is used, and what control users retain over their personal information (Padyab & Ståhlbröst, 2018).

This thesis aims to delve into these individual privacy concerns, exploring the nuanced ways in which users perceive, react to, and manage their privacy within MR contexts. Through a series of semi-structured interviews, this study seeks to uncover the key privacy issues experienced by MR users and understand how these concerns are influenced by social interactions within MR environments. By focusing on the user perspective, this research intends to contribute to the development of MR technologies that respect user privacy and autonomy, fostering environments where users can engage confidently and securely.

1.1 Problem Background

Mixed Reality (MR) represents a significant frontier in human-computer interaction, blending elements of the physical and digital worlds to create immersive and interactive experiences. As technology continues to advance at an unprecedented pace, the emergence of MR, propelled by devices like Microsoft HoloLens, Magic Leap, and Oculus Quest, has captured the imagination of both consumers and industry professionals (Liang & Huang, 2023).

This integration of digital content into the physical world, while offering profound opportunities for enhancing daily activities, educational experiences, and professional engagements, also introduces complex privacy considerations. The blending of digital and physical realms in MR environments challenges traditional notions of privacy (De Guzman et al., 2023; Liang & Huang, 2023). Users in MR settings navigate a realm where digital content is overlaid on physical reality, potentially exposing personal data and behaviors to new forms of surveillance and data collection. This raises significant concerns about who can access this data, how it is used, and what control users retain over their personal information (Padyab & Ståhlbröst, 2018).

As MR technologies become increasingly integrated into various aspects of daily life, understanding the privacy implications associated with these immersive environments is crucial. This study aims to shed light on the nuanced privacy concerns experienced by individuals when engaging in social interactions within MR contexts. By discerning the specificities of privacy apprehensions across different types of social interactions—such as collaborative work, socializing, or gaming—the research intends to provide insights that can inform the development of privacy-preserving design principles and policies for MR platforms and applications (Thilakarathna et al., 2023).

Research indicates that individuals may experience feelings of exposure or vulnerability within MR environments due to uncertainties surrounding privacy boundaries. The seamless integration of virtual elements into the real world can lead to challenges in distinguishing between public and private interactions, impacting users' perception of privacy. Furthermore, as MR becomes increasingly accessible, it is essential to address emerging privacy challenges to safeguard individuals' rights and autonomy. Bridging the gap in understanding the privacy landscape of MR requires interdisciplinary research efforts that explore the technical, social, and ethical dimensions of privacy within MR environments (De Guzman et al., 2023).

2.1 Research Aim and Questions

The primary aim of this study is to investigate the key privacy concerns faced by individuals engaging in Mixed Reality (MR) environments, with a specific focus on how these concerns vary across different types of social interactions within MR. The study delves into the multifaceted nature of privacy in MR to identify common themes and variations in privacy apprehensions that arise during social interactions in MR settings. This exploration aims to contribute to the creation of MR environments that prioritize user privacy and foster trust among participants, thereby facilitating the responsible and ethical advancement of mixed reality technology.

Main Research Question: What are the key privacy concerns experienced by individuals in mixed reality use situations, and how do these concerns vary across different social interactions in MR?

These research questions are designed to bridge the gap in understanding the privacy landscape of MR, acknowledging the evolving nature of user concerns in the face of immersive technologies. The insights gained from this study aim to inform design practices, user education, and policy development, enhancing user engagement and trust in MR technology.

3.1 Contribution

This research advances the understanding of privacy concerns in Mixed Reality (MR) environments by focusing on individual experiences across various social interactions. It makes significant theoretical and practical contributions to the rapidly evolving field of MR technologies. Theoretically, it enriches academic literature by exploring how privacy concerns manifest in different social interactions such as gaming, social media, and professional collaborations thereby contributing to theories on digital privacy and human-computer interaction. Additionally, it aids in developing a nuanced framework categorizing various privacy concerns in MR, providing a structured way to assess privacy risks.

Practically, the study informs the development of privacy-aware MR applications by offering recommendations for MR developers to integrate privacy considerations at the design stage, thus fostering experiences that respect user privacy and minimize unintended breaches. Furthermore, by elucidating privacy challenges and management strategies, the research aims to increase user awareness and empower them to navigate their privacy effectively. This interdisciplinary study bridges technology, user experience, and privacy law, encouraging collaborations across informatics, cybersecurity, and legal studies, thereby enhancing the societal and ethical implications of MR technologies to ensure they evolve in a manner that benefits users and respects their privacy rights.

4.1 Delimitations

This research focuses on exploring individual privacy concerns in mixed reality (MR) use situations. While acknowledging the broader ethical and social implications of MR technologies, the study is delimited to privacy-related issues and dynamics within MR environments. The research aims to capture diverse perspectives from MR users worldwide, but cultural and regional differences in privacy norms and attitudes may influence the study's findings.

The research will involve interviewing 10 active MR technology users to ensure a wide range of experiences and perspectives are represented. It will use a qualitative approach, specifically semi-structured interviews, to delve into individual privacy concerns in MR use situations. The study's findings will be based on the current state of MR technologies and user experiences at the time of data collection, and ethical guidelines and principles will be adhered to throughout the research process.

Although the study does not extensively explore the perspectives of developers, policymakers, or other stakeholders involved in the design, development, and regulation of MR technologies, it aims to provide insights into user perspectives on privacy in MR use situations.

2. Background

The chapter of this thesis serves several critical functions in setting the stage for the research on privacy concerns in mixed reality (MR) environments. This chapter begins by providing a detailed overview of the emergence and development of MR technologies, explaining how they blend physical and virtual worlds to create immersive experiences. It delves into the operational mechanics of MR, describing the various types of applications including empowering, integrated, and immersive environment applications.

2.1 What is Mixed Reality and How Does it Work

Following the evolution of computing from mainframes and PCs to smartphones, mixed reality (MR) is emerging as the next significant advancement. It offers immersive experiences that blend the physical and virtual worlds, becoming increasingly popular among both consumers and businesses. MR enables intuitive interactions with data in personal spaces and social circles, breaking away from the constraints of screen-based experiences (Liang & Huang, 2023).

Millions of online users worldwide have already experienced MR through their handheld devices, especially mobile augmented reality (AR) on social media platforms. Many users may not even realize that AR filters on Instagram are MR experiences. Windows Mixed Reality enhances these experiences with stunning holographic depictions of people, high-quality 3D holographic models, and the surrounding real world (Wen et al., 2023). This new reality is made possible by advancements in computer vision, graphics processing, display technologies, input systems, and cloud computing (Wen et al., 2023).

The term "mixed reality" was initially coined in 1994 by Paul Milgram and Fumio Kishino in their article "A Taxonomy of Mixed Reality Visual Displays," which presented the concept of a virtuality continuum and the categorization of visual displays. Over the years, MR has expanded beyond displays to include environmental perception, human perception (such as hand-tracking, eye-tracking, and speech input), spatial sound, and collaboration on 3D assets (Milgram & Kishino, 1994).

MR blends virtual and real-world environments into a single, immersive experience, offering intuitive interactions with data in personal spaces and social circles (Juraschek et al., 2018). The convergence of physical and digital domains has enabled seamless three-dimensional interactions among humans, computers, and surroundings, facilitated by breakthroughs in technology.

Using MR applications involves engaging with the real world, then integrating virtual layers such as objects, text, images, and animations into the physical environment to create an enriched, interactive experience (De Guzman et al., 2019). This digital content enhances user interaction, and MR applications collect and analyze data to create tailored mixed virtual worlds for various purposes.

MR has practical applications in education, entertainment, and training. It can create interactive learning experiences, immersive games, and training simulations for real-world scenarios (Albeedan et al., 2024; Verhey et al., 2020).

MR and AR share similarities, but MR goes beyond overlaying digital objects by creating interactive experiences that seamlessly blend both worlds (Cheok et al., 2007). The success of MR depends on developing a robust human-machine connection, recognizing and interpreting various movements within a space (Sala, 2020).

Creating digitally augmented experiences in MR relies on sophisticated data processing mechanisms integrating sensory inputs from cameras, sensors, and AI-enabled technologies (Sala, 2020). MR glasses, combined with specialized software algorithms, capture and process extensive environmental data to generate a virtual representation of the physical space, overlaying holographic images and contextual information (Sala, 2020).

Three core components are essential for authentic MR experiences: cloud-enabled computational processing, sophisticated input modalities, and accurate perception of the environment (Prabowo et al., 2023; Santos et al., 2023; Ramadhan et al., 2023). These elements work together to create a cohesive MR experience that merges virtual and physical realms (Suryodiningrat et al., 2023).

Our actions in the physical world are mirrored in a digital counterpart as we navigate through our surroundings. The boundaries between the physical and digital worlds blur, creating a more fluid and immersive experience (Sala, 2020). The synergy among these elements fosters a seamless and captivating immersive MR experience.

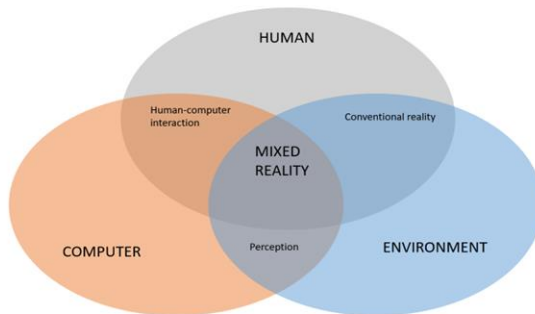


Figure 1 The interactions between computers, humans, and environments (Author's own)

Figure 1 represents the concept of mixed reality. Here's a breakdown of its components (Juraschek et al., 2018):

- **Human-Computer Interaction:** The overlap between the “HUMAN” and “COMPUTER” circles, highlights how humans interact with computer systems.
- **Conventional Reality:** The overlap between the “HUMAN” and “ENVIRONMENT” circles, indicates the natural, unaltered state of the world as we experience it.
- **Perception:** The overlap between the “COMPUTER” and “ENVIRONMENT” circles, could refer to the way computers interpret or simulate the environment.
- **Mixed Reality:** At the center, where all three circles intersect, it signifies the blending of real-world and digital elements to create new environments where physical and digital objects co-exist and interact in real-time.

This figure helps to visualize how mixed reality is an integration of human experiences, technological interaction, and environmental perception.

2.2 Types of Mixed Reality Applications

Mixed reality (MR) offers a spectrum of experiences, from immersive virtual environments to subtle overlays of the user's physical surroundings. This versatility allows developers to craft diverse experiences tailored to specific needs and contexts (Sala, 2020). At the outset of development, understanding where an application lies on this spectrum is crucial, as it not only shapes the design but also influences the technological approach and associated privacy considerations (Sala, 2020).

2.2.1 Empowering Environment Application

Empowering Environment Applications in MR seamlessly integrate digital content with the user's immediate environment. This integration is critical for applications where the contextual overlay of digital information can augment the user's real-world experience, thereby enhancing user engagement and interaction without pulling them out of their physical context (Rwinj & Tieto, 2022; Rambach et al., 2021).

Unlike Integrated Environment Applications, which primarily focus on merging environments, EEAs empower users with greater control and personalization of the MR content (Rwinj & Tieto, 2022; Bankanal et al., 2021). Features such as customization allow users to adjust virtual elements in real-time, offering actionable insights and enhanced learning through interactive tutorials that adapt to user interaction, thereby fostering a sense of agency and control (Schäfer et al., 2021; Bankanal et al., 2021).

Examples of Empowering Environment Applications (EEA) (Rwinj & Tieto, 2022; Bankanal et al., 2021):

- **Fitness Training:** Personalized workouts with virtual guidance.
- **Language Learning:** Real-time translation overlays during travel
- **Medical Procedures:** Surgeons receive enhanced visual data during operations.

2.2.2 Integrated Environment Applications

Integrated Environment Applications are designed to blend the digital and physical realms seamlessly. These applications leverage the capabilities of MR to enhance user interaction across multiple settings, such as education, design, and maintenance, by merging real-world elements with virtual data to create a cohesive experience (Rwinj & Tieto, 2022; Laniak et al., 2013).

Examples of IEA in MR (Rwinj & Tieto, 2022; Goodall et al., 2013):

- **Education and Training:** Students explore 3D historical simulations.
- **Design and Manufacturing:** Real-time collaborative design sessions.
- **Remote Collaboration:** Teams interact with shared virtual models.

2.2.3 Immersive Environment Applications

These applications transport users to entirely virtual settings, creating experiences that are vivid and engaging, extending beyond the integration of real-world elements. Immersive environments allow users to experience fully digital worlds, often detaching from the physical context (Rwinj & Tieto, 2022; Abbasi & Baroudi, 2012).

Examples of IEA in MR (Rwinj & Tieto, 2022; Abbasi & Baroudi, 2012):

- **Virtual Tourism:** Exploring distant locations virtually.
- **Advanced Gaming:** Engaging in fully immersive game environments.

2.3 Privacy Concerns and Social Interactions in (MR)

Mixed Reality (MR) technologies represent a groundbreaking fusion of the physical and virtual realms, offering users immersive experiences that blur the boundaries between reality and simulation. As these technologies continue to advance and permeate various aspects of society, they bring forth a host of ethical and privacy considerations (De Guzman et al., 2023). The transformative nature of MR raises critical questions about individual privacy rights, as users navigate digital environments that intricately intersect with the real world. Understanding the nuanced dimensions of privacy within MR contexts is essential for ensuring the responsible development, adoption, and regulation of these technologies (Tang et al., 2020; De Guzman et al., 2023).

2.3.1 Data Privacy and Surveillance in Mixed Reality

One of the primary concerns in MR is the collection and use of personal data. As we delve deeper into this realm, we confront significant privacy and security challenges (Tang et al., 2020). MR devices collect vast amounts of personal and sensitive data this data can be used to personalize experiences, improve performance, and enhance functionality, raising concerns about data privacy (De Guzman et al., 2023; Seneviratne et al., 2021). Users' movements, interactions, and surroundings are meticulously tracked, potentially leading to unauthorized monitoring and misuse of personal data (Kasprowski et al., 2012). Additionally, MR systems create detailed spatial maps, including personal belongings and sensitive information, posing risks of inadvertent capture and exploitation (Kasprowski et al., 2012). Biometric data, integral to MR, raises privacy concerns regarding user consent and control (Kasprowski et al., 2012).

After looking at the pictures displayed in Figure 2 below, it is clear that a large amount of data has been collected using mixed reality. These images prove the significant amount of information that can be obtained and analyzed with the help of mixed reality technology.

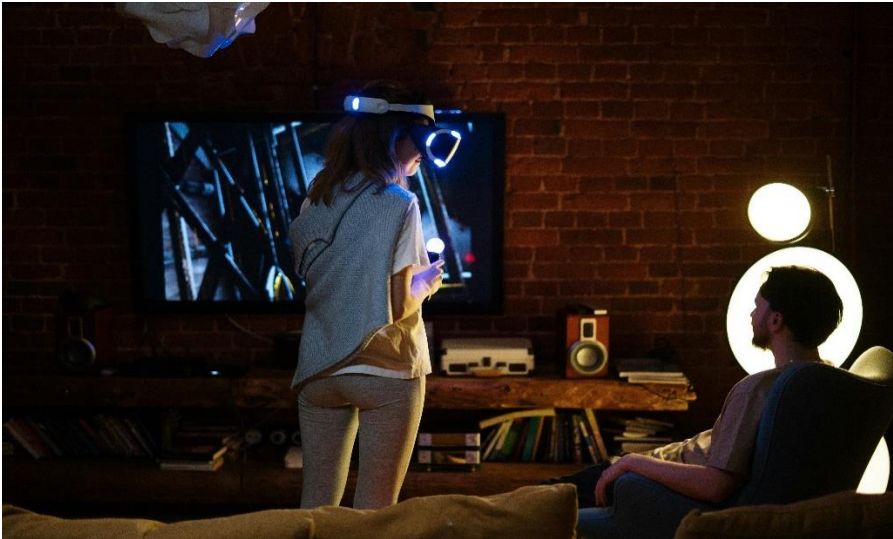


Figure 2 Information Mixed reality collecting¹ (cottonbro studio 2021)

2.3.2 Collaborative Interactions and Data Exposure in Mixed Reality

Social interactions within MR environments further complicate the privacy landscape. Social interactions play a fundamental role in human behavior, shaping our relationships, identities, and decision-making processes (Maloney et al.,

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2020). They occur in various contexts, including face-to-face interactions, online communities, and group settings. Within these interactions, individuals exchange information, express emotions, and engage in collaborative activities (Zamanifard et al., 2020; Byrne et al., 2024). As users interact with each other in virtual spaces, they must navigate complex social norms and expectations, often without clear guidelines or boundaries. This can make users feel exposed or vulnerable, especially if they perceive a lack of control over their digital persona or interactions (Freeman et al., 2020).

Privacy concerns on MR (Mixed Reality) platforms stem from their inherently social nature. These platforms often necessitate the sharing of personal information to adhere to company policies and engage with others in virtual events, meetups, or gatherings (Seneviratne et al., 2021). As users immerse themselves in MR environments, they may find themselves disclosing sensitive data or inadvertently exposing aspects of their identity to others present in the virtual space (Freeman et al., 2020; Seneviratne et al., 2021). One primary reason for privacy apprehensions in MR platforms is the requirement to divulge personal information for participation. Whether it's registering with a real name, providing contact details, or linking accounts to social media profiles, users often face pressure to share data as part of the platform's functionality or community guidelines. This mandatory sharing raises concerns about data security, unauthorized access, and the potential misuse of personal information by platform operators or other users (Freeman et al., 2020; Seneviratne et al., 2021).



Figure 3 Information you share in Social interaction (Julia M Cameron 2020)

The image² brings to light a significant privacy concern commonly encountered in mixed reality (MR) and virtual meeting scenarios: the accidental revelation of one's private domain. The participants in the meeting, situated within their abodes—areas typically reserved for private life like bedrooms—might unwittingly display their living spaces (Gugenheimer et al., 2022; De Guzman et al., 2019). These spaces, replete with personal items and decor, are often deeply personal and the inadvertent exposure of such details in a background might inadvertently (Tseng et al., 2022; Thilakarathna et al., 2019). communicate preferences and lifestyles that one usually chooses to keep private.

2.3.3 Security Threats and Vulnerabilities

The integration of physical and virtual environments in MR also brings forward concerns about information security and cybersecurity. It is crucial to identify and mitigate potential vulnerabilities that could be exploited by malicious entities, ensuring that MR technologies are secure and trustworthy (Seneviratne et al., 2023).

2.4 The Need for Research

The rapid proliferation of Mixed Reality (MR) technologies necessitates urgent research to comprehend the inherent privacy concerns and dynamics in these use scenarios. Understanding individual experiences, perceptions, and coping mechanisms regarding privacy in MR can help identify key challenges and opportunities for addressing privacy concerns effectively. Research can inform guidelines, best practices, and policy frameworks to ensure the responsible use of MR technologies. Collaboration among stakeholders from industry, academia, and civil society is essential to develop solutions that balance innovation with privacy protection, ensuring that MR evolves in a manner that benefits society.

The seamless integration of digital and physical elements in MR environments challenges traditional privacy notions and introduces novel concerns. Interactions with MR technologies involve not only digital interfaces but also the surrounding physical environment, leading to complex privacy dynamics. Understanding these nuances is crucial for ensuring the responsible development, adoption, and regulation of these technologies.

As MR becomes increasingly integrated into daily life, addressing emerging privacy challenges is imperative to safeguard individual rights and autonomy. Bridging the gap in understanding the privacy landscape of MR requires interdisciplinary research efforts that explore the technical, social, and ethical dimensions of privacy within MR environments.

Research can inform the development of privacy-enhancing technologies, design guidelines, and policy frameworks that promote user trust and confidence in MR systems (Cai et al., 2019). By examining how social interactions, technological

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features, and contextual factors influence privacy concerns and behaviors in MR, researchers can identify best practices for mitigating privacy risks and ensuring user privacy and autonomy in this evolving technological landscape (Cai et al., 2019).

This research aims to bridge the gap in understanding MR's privacy landscape, acknowledging the evolving nature of user concerns in the face of immersive technologies. The primary objective is to explore individual privacy concerns in MR and understand how social interactions within MR environments impact these concerns. Additionally, it seeks to determine if individuals prioritize privacy more when interacting with others in virtual spaces compared to solo experiences (Cai et al., 2019).

2.5 Existing Research

The exploration of privacy in Mixed Reality (MR) is further illuminated by the study "Security and Privacy Approaches in Mixed Reality: A Literature Survey," authored by De Guzman et al. in 2019. This work provides a detailed examination of the security and privacy concerns within MR, emphasizing the rapid technological advances and the lag in developing concurrent privacy protections. The survey outlines a variety of strategies to secure MR environments and highlights the importance of integrating these measures early in the development cycle, ensuring a balanced approach to user interaction and device security (De Guzman et al., 2019).

In conjunction, the study by Ali Padyab and Anna Ståhlbröst on "Exploring the Dimensions of Individual Privacy Concerns about the Internet of Things Use Situations" provides a parallel view, focusing on the integration of IoT devices into everyday life. This research identifies similar privacy concerns, such as extensive data collection and the risk of unauthorized use, stressing the importance of a user-centered approach in IoT policy and service design. This comparative view of IoT and MR underscores the unique challenges posed by the seamless integration of these technologies into daily life, highlighting fourteen dimensions of privacy concerns that can be adapted to understand MR scenarios better (Padyab & Ståhlbröst, 2018).

Both studies underscore the need for stringent privacy protections and user-centric approaches in emerging technologies. They provide a comprehensive foundation for understanding the current state of privacy and security in MR, which aligns with and enriches the focus of this thesis on individual privacy concerns within MR environments.

3. Methodology

This chapter details the chosen research methodology, highlighting the qualitative research approach and specific techniques for data collection and analysis. Additionally, it outlines the steps taken to ensure the reliability and validity of the results and justifies these choices. The section also addresses the delimitations and ethical considerations involved in the methodological approach, particularly in the context of archiving interview data, ensuring the protection and confidentiality of participants' information. This ensures that all collected data, including interview recordings and transcripts, are securely stored and anonymized to maintain the integrity and ethical standards of the research process.

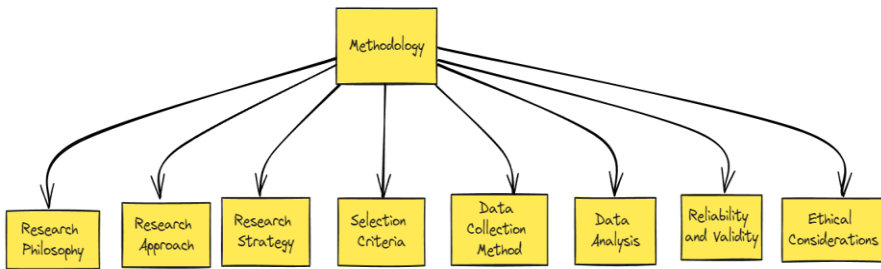


Figure 4 flowchart to represent the research Methodology (Author's own)

3.1 Research Philosophy

The outer layer of Saunders' Research Onion (2007), philosophical assumptions, constitutes the fundamental beliefs and perspectives that underpin a research study (Saunders et al., 2007). In the context of this thesis, the choice between positivist and interpretive philosophical assumptions was deliberate (Saunders et al., 2007).

Positivist and interpretive philosophical paradigms represent two distinct approaches to research, each grounded in different ontological, epistemological, and methodological assumptions. Positivism assumes that there is an objective reality that exists independently of human perception, emphasizing stability, observability, and measurability (Lewis et al., 2007). Knowledge is discovered through empirical observation and experimentation, with an emphasis on objectivity and quantifiability (Thornhill et al., 2007). Positivist research relies on deductive reasoning, hypothesis testing, and quantitative data collection methods to identify causal relationships and generalize findings.

In contrast, interpretivism contends that reality is socially constructed and subjective, shaped by individuals' interpretations and experiences (Thornhill et al.,

2007). Knowledge is context-dependent and socially situated, emphasizing understanding human behavior through qualitative exploration of meanings and experiences. Interpretive research employs methods such as interviews and observations to uncover underlying meanings and socio-cultural influences. The choice between positivism and interpretivism depends on the research question, objectives, and the nature of the phenomenon under investigation (Lewis et al., 2007).

Considering my thesis topic, "Exploring Individual Privacy Concerns in Mixed Reality Use Situations," an interpretive philosophical assumption would be more suitable. This aligns with the endeavor of this thesis to explore privacy concerns in mixed reality environments, where subjective experiences and social interactions play a pivotal role in shaping individuals' perceptions of privacy (Saunders et al., 2007). In the context of this thesis on privacy concerns in mixed reality (MR), philosophical assumptions serve as the guiding principles shaping the researcher's worldview and approach to knowledge generation. Adopting an interpretive stance acknowledges the subjective nature of privacy experiences within MR environments, recognizing that individuals construct their realities through their unique interpretations and interactions (Lewis et al., 2007).

By embracing interpretivism, the research seeks to delve into the lived experiences and perceptions of MR users, understanding privacy concerns from their subjective viewpoints (Thornhill et al., 2007). This epistemological stance emphasizes the importance of context, social interactions, and individual meanings, enabling a nuanced exploration of the intricate dynamics between technology and privacy in the MR landscape. Through the lens of interpretivism, the study aims to uncover the underlying meanings and intricacies of privacy in MR, contributing to a deeper understanding of this emerging phenomenon.

By embracing an interpretive philosophical assumption, you can engage in an in-depth exploration of privacy concerns in mixed reality, capturing the richness and diversity of individual experiences. This approach aligns with the complexity of your research topic and facilitates a comprehensive understanding of privacy dynamics within mixed reality environments (Lewis et al., 2007).

3.2 Research Approach

Saunders' Research Onion (2007) has several layers. The second layer is an important component of this research model. It pertains to the research approach, which encompasses the overarching strategy guiding the investigation's design and execution. In the context of this thesis on privacy concerns in mixed reality (MR), the chosen research approach is qualitative. Qualitative research is characterized by its focus on understanding social phenomena from the perspectives of the participants, exploring the richness and complexity of human experiences, and uncovering the underlying meanings behind observed behaviors (Saunders et al., 2007). This approach aligns with the study's objective of comprehensively exploring the nuanced privacy concerns experienced by individuals in MR environments and understanding how these concerns vary across social interactions (Saunders et al., 2007).

Qualitative research offers several advantages for studying privacy concerns in MR. Firstly, it allows for a deep exploration of participants' lived experiences, perceptions, and emotions, providing rich insights into the multifaceted nature of privacy in MR (Thornhill et al., 2007). Through qualitative methods such as semi-structured interviews, researchers can engage in in-depth conversations with participants, probing into their thoughts, attitudes, and behaviors related to privacy in MR. Additionally, qualitative research facilitates the exploration of contextual factors that influence privacy concerns, such as social norms, cultural values, and technological affordances (Thornhill et al., 2007).

Moreover, qualitative research is well-suited for studying complex and emerging phenomena, such as privacy in MR, where little existing research exists and where quantitative data may not capture the intricacies of human experiences. By adopting a qualitative approach, this study aims to generate new knowledge and insights that contribute to a deeper understanding of privacy dynamics in MR environments (Lewis et al., 2007).

The qualitative research approach also allows for flexibility and adaptability throughout the research process. Researchers can iteratively refine their data collection methods and analytical strategies in response to emerging findings, ensuring that the study remains responsive to the complexities of the research context (Lewis et al., 2007). Additionally, qualitative research emphasizes the importance of reflexivity, encouraging researchers to critically reflect on their own biases, assumptions, and interpretations throughout the research process. This reflexivity enhances the rigor and credibility of the study by promoting transparency and self-awareness (Lewis et al., 2007).

In implementing the qualitative research approach, the study will primarily rely on semi-structured interviews as the main data collection method. Semi-structured interviews offer a balance between flexibility and structure, allowing researchers to explore predefined themes while also remaining open to unexpected insights and perspectives (Saunders et al., 2007). Through interviews conducted remotely using virtual communication platforms, the study aims to engage with a diverse range of MR users, including gamers, social media users, and professionals, to capture a comprehensive understanding of privacy concerns in MR across different contexts and user groups (Saunders et al., 2007).

While structured interviews provide a high degree of consistency and are useful for collecting data that can be easily compared across participants, their rigid format limits the depth and nuance of responses (Mueller & Segal, 2015). Given the complex and personal nature of privacy concerns in MR environments, structured interviews could prevent participants from sharing their unique experiences fully, thereby offering less insight into the intricate dynamics influencing their attitudes and behaviors (Mueller & Segal, 2015).

On the other hand, fully open or unstructured interviews allow for free-flowing conversations but can result in data that is less focused and more challenging to analyze, particularly when identifying specific themes and patterns

(Magaldi & Berler, 2020). This format could lead to responses that deviate from the core research questions and provide less actionable findings (Magaldi & Berler, 2020).

Semi-structured interviews balance structure and flexibility, enabling researchers to focus on key themes while allowing participants to share unexpected insights (Magaldi & Berler, 2020).

This approach is ideal for exploring privacy concerns in MR because it encourages in-depth conversations while maintaining enough focus to capture relevant data systematically. This ensures that the study remains both comprehensive and adaptable to the complexities inherent in understanding privacy dynamics in immersive digital environments (Magaldi & Berler, 2020).

The qualitative data collected through semi-structured interviews will be analyzed using thematic analysis, a method for identifying, analyzing, and reporting patterns (themes) within the data. Thematic analysis involves systematically coding and categorizing the interview transcripts to identify recurring themes, patterns, and insights related to privacy concerns in MR (Saunders et al., 2007). By following a rigorous and transparent analytical process, the study aims to derive meaningful and actionable findings that contribute to both theoretical knowledge and practical implications for MR developers, policymakers, and users (Saunders et al., 2007).

In summary, the qualitative research approach adopted in this thesis offers a robust and flexible framework for exploring privacy concerns in mixed reality environments (Lewis et al., 2007). By engaging with participants in meaningful conversations and analyzing their narratives, the study aims to uncover the underlying complexities of privacy in MR and contribute to a deeper understanding of this emerging phenomenon (Thornhill et al., 2007).

3.3 Research Strategy

The third layer of Saunders' Research Onion pertains to the research strategy, which outlines the specific methods and techniques used to collect and analyze data in line with the chosen research approach. For this thesis on privacy concerns in mixed reality (MR), the research strategy involves a combination of data collection methods, data analysis techniques, and procedures to ensure the validity and reliability of the findings (Thornhill et al., 2007).

This research employs a qualitative approach, specifically semi-structured interviews, to explore key privacy concerns experienced by individuals in MR use situations and how these concerns vary across social interactions. Qualitative methods are well-suited for understanding the lived experiences and perceptions of individuals, which is crucial for exploring complex and nuanced issues like privacy in emerging technologies (Kallio et al., 2016).

A qualitative approach was chosen over quantitative methods due to the deeply personal nature of privacy concerns in MR environments (Streefkerk, 2023; Allwood, 2011). While quantitative studies can provide statistical data on privacy issues, they often lack the depth needed to fully understand individual users' perspectives and the social dynamics influencing their privacy perceptions.

The qualitative data will be coded using thematic analysis—an approach to identify, analyze, and report patterns or themes within the data. This process involves systematically coding and categorizing interview transcripts to uncover common themes, patterns, and insights regarding privacy concerns in MR (Dawadi, 2020). This iterative process helps researchers find hidden meanings and interpretations within the data, offering a rich and intricate understanding of privacy dynamics in virtual environments (Dawadi, 2020).

3.4 Selection Criteria

The participant group for this research is individuals who actively use mixed reality technologies for various purposes, such as gaming, social interaction, or professional applications. Convenience and purposive participant inclusion criteria will be used to recruit participants who meet the following criteria:

- Have at least two years of experience in the field of mixed reality
- Have experience using at least one mixed-reality application.
- Engage in both solo and social interactions within MR environments

The initial goal is to interview approximately 10 participants to achieve data saturation, where no new themes or insights emerge from further interviews. Among these participants, there will be developers of mixed reality applications and platforms, and they will be interviewed on the basis that they are individuals with good experience. However, additional participants may be recruited if necessary to ensure comprehensive coverage of different MR experiences and perspectives (Kallio et al., 2016). The table below lists the participants' experiences in MR, including the purpose of using MR, and to protect the privacy of the participants while ensuring the accuracy of the data, certain identifying details such as names, locations, job titles, and organization names have been excluded. Instead, a unique identifier is denoted as "X".

Table 1 Overview of participants

participants	purpose
X1	Gaming, Design Work, Daily uses
X2	Gaming, Design Work, Daily uses
X3	Gaming, Design Work, Daily uses
X4	Design Work, Daily uses
X5	Gaming, Design Work, Daily uses
X6	Gaming, Design Work, Daily uses
X7	Gaming, Design Work, Daily uses
X8	Design Work, Daily uses
X9	Gaming, Design Work, Daily uses
X10	Gaming, Design Work, Daily uses

3.5 Data Collection Method

The primary method of data collection for this thesis was semi-structured interviews conducted remotely using virtual communication platforms. Semi-structured interviews offered the flexibility to explore predefined topics while also allowing for open-ended discussions that captured participants' unique perspectives and experiences (Busetto et al., 2020). This approach not only engaged participants but also empowered them to contribute substantially to the dialogue (Kallio et al., 2016). The use of virtual communication platforms enabled remote data collection, transcending geographical boundaries, and facilitating engagement with a diverse range of MR users (Newman et al., 2021).

3.5.1 Interview Questions

The interview questions for this study were developed based on the frameworks and insights presented in the second chapter, particularly informed by the influential paper by Padyab & Ståhlbröst (2018). This previous work significantly guided the selection of questions, ensuring they aligned with the research objectives and facilitated the collection of rich and meaningful data on privacy concerns in mixed reality (MR) environments.

Care was taken to craft open-ended questions that allowed participants to express their thoughts and experiences freely, thereby enabling a thorough exploration of their perspectives without introducing biases (Kallio et al., 2016). The questions specifically probed participants' attitudes toward data collection in MR, their comfort levels with sharing personal information, and any privacy breaches they had experienced. This meticulous formulation aimed to cover various aspects of privacy, capturing a wide range of insights to foster a holistic understanding of the subject (Bernard et al., 2018). Additionally, follow-up questions were strategically included to probe deeper into topics or clarify any ambiguous responses, creating a dynamic and interactive interview process. This approach not only engaged participants but also empowered them to contribute substantially to the dialogue (Kallio et al., 2016).

The interview was structured into four main sections: The introductory section included a brief explanation of the study's purpose, the interview process, the estimated duration, and confidentiality measures, along with obtaining verbal consent to proceed and record the interview. The subsequent sections focused on basic information, privacy concerns and experiences, and social interactions related to privacy, respectively. This structured yet flexible format ensured that all pertinent topics were thoroughly addressed while accommodating.

3.5.2 Interview Guide

Given the potential constraints that may have hindered face-to-face meetings, this study utilized remote interviews to demonstrate the efficacy of virtual communication platforms in fostering meaningful dialogue (Newman et al., 2021). The remote nature of these interviews did not hinder the depth of discussions

but rather expanded the reach, transcending geographical boundaries and engaging companies that might otherwise have been inaccessible (Bavik et al., 2021). This approach showcased the adaptability of modern communication technologies and underscored the global relevance of the research topic.

These interviews offered versatility and dynamic interaction, enhancing the probing questions' effectiveness. According to Kallio et al. (2016), the interview guide included questions that steered the conversation toward the research question, addressing key themes systematically. A comfortable atmosphere was fostered by gradually introducing the main themes and using follow-up questions to ensure consistency and detailed responses.

To establish a connection between the interviewer and the respondent, it was essential to start with introductory questions that provided information about the interview process and topic (Kangasniemi et al., 2016). Consent was obtained regarding the documentation of interview data and its handling, such as the use of names and recordings. These introductory questions helped establish rapport and a level of comfort, resulting in more candid and truthful responses (Kangasniemi et al., 2016).

To establish a connection between the interviewer and the respondent, it is essential, to begin with introductory questions that provide the interviewees with information about the interview process and the topic (Kangasniemi et al., 2016). Consent should be obtained regarding the documentation of the interview data and its handling, such as the use of the name, recording, etc. These introductory questions can also help establish a rapport and a level of comfort between the interviewer and the respondent, which can result in more candid and truthful responses (Kangasniemi et al., 2016).

Actions before the interview;

- Question

Section 1: Background Information;

- Question 1

Section 2: Privacy Concerns and Experiences;

- Question 1
- Follow-up question

Section 3: Social Interactions and Privacy;

- Question 1
- Follow-up question

For a complete interview guide, including the sections and question structure, please refer to Appendix A.

3.5.3 Invitation to Participate

As part of a study on privacy concerns in mixed reality environments, potential participants were invited to participate in an interview process via email (Appendix B). The email was carefully crafted to ensure that both the researcher and the

respondents had a clear understanding of what to expect during the upcoming interviews.

The email invitation briefly introduced the research topic and the researcher's academic and professional background. It communicated the primary aim of the study, which was to explore individual privacy concerns within mixed reality contexts. By doing so, the invitation aimed to attract respondents who had a vested interest or experience in mixed reality technologies, fostering a relevant and insightful dialogue during the interviews.

The invitation also provided respondents with several date and time options for the interviews, offering flexibility to accommodate their diverse schedules. This consideration was important in enhancing participation rates and ensuring that respondents could engage in the study at their convenience. Furthermore, the invitation emphasized a firm commitment to ethical principles, including maintaining confidentiality, ensuring anonymity, and upholding the integrity of the research process and the data collected. This reassurance was vital in building trust between the researcher and the respondents.

3.6 Data Analysis

The qualitative data collected through semi-structured interviews were meticulously analyzed using thematic analysis. This method systematically identifies, analyzes, and reports patterns within the data, allowing me to uncover recurring themes, patterns, and insights that address privacy concerns in mixed reality (MR) environments. The iterative process of coding and categorizing the transcripts revealed underlying meanings and provided a comprehensive understanding of privacy dynamics within virtual environments (Dawadi, 2020).

A crucial aspect of this analysis was the formulation of specific research questions that guided the examination of the data. These questions framed the interpretation and facilitated the extraction of meaningful insights by focusing on participants' experiences, perceptions, and attitudes toward privacy in MR, along with the factors influencing their privacy-related behaviors.

Thematic analysis, as a qualitative research method, enabled the identification and interpretation of patterns and themes within the data. This flexible and inductive approach allowed for an in-depth exploration of diverse perspectives obtained during the interviews and from the reviewed literature (Braun & Clarke, 2006; Dawadi, 2020). The process emphasized interpreting non-numerical data to understand the reasons behind observed phenomena, rather than merely confirming their occurrence.

Extracting data from the interviews was essential for the analysis. The recorded interviews were transcribed into written text, forming the basis for data analysis. Each interview was transcribed manually, word-for-word, with personal identifiers such as names, places, roles, and organization names omitted to ensure respondent anonymity while preserving data integrity. Analyzing the qualitative data collected from the interviews was a systematic process requiring careful

consideration and adherence to established methodologies. Following the guidance provided by Dawadi (2020), the analysis approach was applied to the 98 pages and 24,990 words of transcriptions obtained from the interviews.

After the audio recordings were converted into transcripts, they were revisited and compared with the original recordings to ensure that no details, however minor, were omitted. This stage was considered crucial because overlooking any piece of information could negatively impact the data analysis process and its credibility. Once it was confirmed that the transcriptions matched the audio recordings exactly and completely, with no words or information missing, we proceeded to the next stage—the thematic analysis stage.

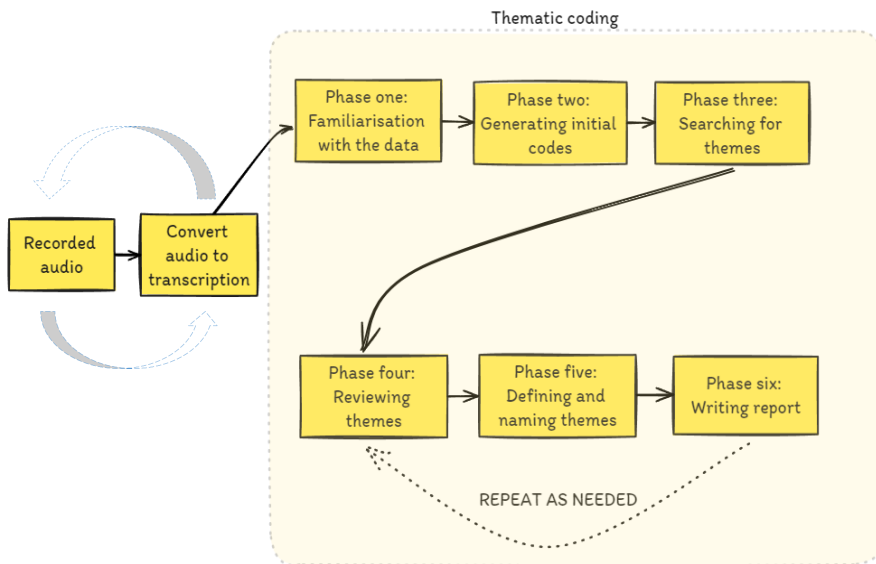


Figure 5 The process of thematic analysis (Author's own).

Figure 5 illustrates the process of thematic analysis that was utilized to analyze the data in this research. Thematic analysis is a method employed in qualitative research to identify, analyze, and report patterns (themes) within data. This process is depicted in a flowchart format, detailing each step involved.

- 1- Recorded Audio: This was the starting point where data for analysis was gathered, primarily through recordings of interviews.
- 2- Convert Audio to Transcription: The recorded audio was transcribed into text format to facilitate detailed analysis. This step involved transforming spoken words into a written document.

- 3- Phase One Familiarization with the Data: The first step in the thematic analysis process involved familiarizing with the data. This encompassed a comprehensive immersion in the transcripts of remote interviews, capturing the essence of participants' responses and the nuances of their experiences (Braun & Clarke, 2006; Dawadi, 2020).
- 4- Phase Two Generating Initial Codes: Following data familiarization, the process of generating initial codes commenced. This involved systematically labeling and categorizing segments of data based on their relevance to the research questions and objectives. The codes functioned as the building blocks for subsequent theme development, enabling the identification of recurrent ideas, concerns, or concepts embedded in the dataset (Braun & Clarke, 2006; Dawadi, 2020).
- 5- Phase Three Searching for Themes: In Phase Three of the data analysis process, which was called Searching for Themes, the focus shifted to identifying broader patterns or themes that could capture the underlying meanings within the coded data (Braun & Clarke, 2006; Dawadi, 2020). This involved gathering all the codes and relevant data extracts to identify potential themes. Themes were developed based on how different codes combined to narrate a significant aspect of the data. Each potential theme was reviewed to ensure that it formed a coherent pattern (Braun & Clarke, 2006; Dawadi, 2020).
- 6- Phase Four Reviewing Themes: In phase this of the research process, the identified themes were critically evaluated to ensure their coherence and accuracy in reflecting the meanings evident in the dataset (Braun & Clarke, 2006; Dawadi, 2020). This involved refining the themes by either splitting them into sub-themes or combining them with others to provide a more precise and insightful representation of the data. The goal of this stage was to ensure that the themes were well-defined and accurately reflected in the dataset (Braun & Clarke, 2006; Dawadi, 2020).
- 7- Phase Five Defining and Naming Themes: During the five phases, the main focus was on defining and naming the themes related to privacy concerns in mixed reality environments. Each theme was described concisely in a way that told a narrative about what was captured during the research (Braun & Clarke, 2006; Dawadi, 2020). The names for each theme were selected carefully to best represent the essence of what they represented. This stage was essential in ensuring that the findings were presented in a way that was both accessible and academically rigorous, offering clear insights into the research questions (Braun & Clarke, 2006; Dawadi, 2020).
- 8- Phase Six Writing Report: The last phase in the data analysis process for this thesis on individual privacy concerns in mixed reality use situations

was to write the report. This phase was crucial as it converted the analyzed data into a coherent narrative that could be shared with the academic community and other stakeholders. The goal was to present the findings in a structured format that effectively and persuasively communicated the research (Braun & Clarke, 2006; Dawadi, 2020). To enhance the efficiency and depth of this qualitative analysis, the software program NVivo was employed, providing a sophisticated platform for managing, organizing, and extracting meaningful insights from qualitative research data (NVivo Product Tour - Discover the Power of NVivo - Lumivero, 2023).

The dashed line in Figure 5 suggests "REPEAT AS NEEDED" which indicates that this process is iterative. As new insights emerge, the researcher might return to earlier phases to refine codes, adjust themes, or revisit the data.

3.7 Reliability and Validity

Reliability in qualitative research refers to the consistency of the research approach and the replicability of the findings under similar conditions (Golafshani, 2003). In this thesis, reliability is emphasized by:

1. **Consistent Methodology:** Adhering to a structured process in data collection and analysis, using semi-structured interviews and thematic analysis as outlined in the methodology section. This ensures that each participant undergoes a similar interview process, allowing for consistent data collection.
2. **Use of NVivo:** Employing NVivo software to manage and analyze qualitative data organizes large amounts of textual information and enhances the replicability of the coding process by maintaining a transparent and traceable record of how themes and codes are derived.
3. **Detailed Documentation:** The methodology chapter describes each step in the research process in detail, from participant selection to data analysis. This comprehensive documentation supports the reliability of the findings as it enables other researchers to understand and replicate the study procedures.

Validity in qualitative research concerns the accuracy and truthfulness of findings (Golafshani, 2003). Here's how it is emphasized:

1. **Rich Data Collection:** Data were collected using semi-structured interviews, which allowed participants to extensively express their views on privacy concerns in MR environments. This method was likely to capture a broad spectrum of perceptions and experiences, thus enhancing the depth and relevance of the findings.

3.8 Ethical Considerations

Ethical considerations are crucial in qualitative research due to the close contact between participants and researchers, often involving the collection of private and sensitive data (Bell et al., 2022). Researchers must protect participant privacy and personal information from data collection to the publication of results. The primary goal of any study is the participants, and their safety must always take precedence over research objectives (Bell et al., 2022). Additionally, responsibility and transparency are essential in the research process to gain public trust and respect (Bell et al., 2022; Söhner, 2022).

3.8.1 Ethical Considerations During Interviews

During the interview process, it was essential to uphold ethical standards to ensure the well-being and confidentiality of participants. One primary consideration was obtaining informed consent, clearly explaining the study's purpose, the nature of involvement, and any potential risks or benefits. Participants were allowed to ask questions and withdraw from the study at any time without consequences (Bell et al., 2022; Söhner, 2022).

Respecting participant autonomy and privacy was paramount throughout the interview process. This included maintaining confidentiality and anonymity by securely storing and anonymizing interview data to protect participants' identities. Participants were assured they could share their experiences without fear of judgment or reprisal (Bell et al., 2022; Söhner, 2022).

The potential impact of the research on participants' emotional well-being was also considered. Sensitive or triggering topics were approached with empathy and sensitivity, providing support resources and debriefing sessions to mitigate any distress experienced during or after the interviews (Bell et al., 2022; Söhner, 2022).

3.8.2 Dealing with Data Collected During Interviews

Once interview data was collected, we handled it with care to maintain confidentiality and integrity. This involved securely storing audio recordings, transcripts, and any other data obtained during the interviews to prevent unauthorized access or disclosure (Söhner, 2022).

Throughout the analysis process, we remained mindful of the ethical implications of our findings and interpretations. This included respecting participants' confidentiality, accurately representing their perspectives, and avoiding any misrepresentation or distortion of their words (Söhner, 2022).

Finally, we considered how to disseminate our findings ethically and responsibly, ensuring that participants' voices were accurately represented and that the research contributed positively to the advancement of knowledge while minimizing any potential harm or exploitation. This involved seeking participants' input on research outputs, engaging with relevant stakeholders, and adhering to ethical guidelines and standards set forth by professional associations and institutional review boards.

4. Result

In this chapter, the findings from the qualitative research on privacy dynamics in MR environments are discussed. The data were gathered through semi-structured interviews as detailed in section 3.5 and analyzed using thematic analysis, as outlined in section 3.6, revealing insights into the complex nature of privacy within MR contexts. These insights illuminate individual concerns and the broader social implications.

The findings of the chapter are organized around two main themes: "Privacy Concerns and Experiences in MR" and "Social Interactions and Privacy Implications." Each theme discusses key findings and delves into the complexities of privacy dynamics in MR environments. You can refer to Table 2 for a sample of the thematic coding representing various themes.

ID	Data Extracts	Coded for	Main Themes
X1	“Yes, Yes, I do. I have had privacy concerns with using mixed reality technologies. The acquisition of personal data by MR applications not transparently given has led to concerns about possible privacy violations and unintentional access to sensitive information.”	Identity Protection & Privacy	Privacy Concerns
X2	“The use of mixed-reality apps or platforms makes biometric data one of the most vulnerable personal features of information. While attributes such as facial recognition and fingerprint scanning could be used for the purpose of authentication, they also come along with a great deal of risk of unauthorized access or the potential compromise of identity.”	data vulnerability in mixed reality applications	Privacy Concerns
X3	“It was more like I was pushed to agree to some terms in order to continue with group interactions in Mixed Reality and be able to do group activities in other given applications. Yes, friends do have a negative impact on the user in relation to privacy.”	mixed reality group interactions	Social Interactions
X9	“I’m particularly concerned about the security of my financial information and personal communications within MR platforms, These are premises whereby I very much expect high levels of privacy and confidentiality. However, the state of data protection in MR environments currently leaves much to be desired.”	Sensitive Information at Risk	Privacy Concerns
X8	“I feel like I have very little control over how my data is shared and used within MR platforms,”	Lack of Transparency and Control	Privacy Concerns
X5	“With the increasing integration of MR technologies into our daily lives, there’s a growing risk of privacy breaches and identity theft,”	Privacy Breaches and Identity Theft	Privacy Concerns

X7	“I’m worried about how my biometric data, like facial recognition, is being collected and used in MR environments. There’s often no clear consent process, and I’m uncomfortable with companies having access to such sensitive information without my explicit permission.”	Unauthorized Data Collection	Privacy Concerns
X10	“I’m wary of sharing personal information in virtual communities and social platforms within MR environments. There’s often a lack of transparency about how our data is being used, and I worry about the potential consequences of it falling into the wrong hands.”	Virtual Communities	Social Interactions
X4	“One easily notices that an organization has these kinds of policies that require an employee to share some of one’s personal details to be a member of groups and teams at work. Most organizations make these policies with the intention of making members of a work team in search of better organizational coordination.”	Collaborative Workspaces	Social Interactions
X6	“As a gamer, I am concerned with the use of my data for profiling and targeted advertisement within the MR gaming environment. The integration with Social Media only complicates the issues on privacy further, and this is a concern in terms of my personal information”.	Gaming and Entertainment	Social Interactions

Table 2 some examples of Data Extracts and Codes

4.1 Theme 1: Privacy Concerns and Experiences in MR

The analysis of data collected through semi-structured interviews revealed a variety of privacy concerns and experiences among participants in mixed reality (MR) environments. These concerns reflect broader societal anxieties about data privacy and surveillance in the digital age, particularly in immersive virtual environments like MR.

Table 3 encapsulates the primary privacy concerns and experiences mentioned in the document related to the use of mixed reality technologies.

Concern Type	Description
Unauthorized Data Collection	Concerns about personal data being collected without clear consent, including biometric data, location tracking, and unauthorized access to device cameras and microphones.
Lack of Transparency and Control	A lack of transparency in data-sharing practices and insufficient control over personal information within virtual environments lead to apprehension about data misuse.
Invasive Features	Unease about audio and video recordings made within virtual environments without users' knowledge or consent, raising serious privacy concerns.
Privacy Breaches and Identity Theft	Fears about the sharing of personal information within virtual communities or platforms without adequate privacy controls, leading to potential identity theft and unauthorized access.
Vulnerabilities to Data Breaches	Concerns about data breaches or leaks due to vulnerabilities in mixed reality technologies, risking exposure of personal information to malicious actors.
Sensitive Information at Risk	Identification of particularly vulnerable personal information, including location data, biometric data, personal communications, financial information, and identification details.
Fear of Data Misuse	Participants are worried about unauthorized access and the lack of transparency in data handling.
Lack of Control Over Personal Information	Participants feel they lack effective tools to manage how their information is shared.
Insufficient Regulations and Protections	Concerns over the inadequacies of current laws to protect privacy against new technologies.
Security vulnerabilities	Some concerns mixed reality devices could be vulnerable to backdoors and other security flaws that may allow unauthorized parties, such as hackers, to gain access.

Table 3 *Privacy concerns*

Here, we delve into the research findings related to Theme 1: Privacy Concerns and Experiences in MR:

4.1.1 Unauthorized Data Collection

Participants expressed significant concerns about unauthorized data collection in MR environments. X1 lamented, “I’m worried about how my biometric data, like facial recognition, is being collected and used in MR environments. There’s often no clear consent process, and I’m uncomfortable with companies having access to such sensitive information without my explicit permission.”

X4 added, "One concern I encountered was the collection of personal data by mixed reality applications without clear consent or understanding of how that data would be used. This raised concerns about potential privacy breaches and unauthorized access to sensitive information."

Participant X7 added, saying: "There are several ways to associate with data collection in MR. One way is that MR headsets can generate a large amount of data. This data needs to be stored and processed efficiently. Another challenge is that MR data can be very personal. It is important to ensure that MR data is collected and used responsibly."

X1, X5, X9 objected to the data collection policy. Issues included the collection of location data without permission and the activation of audio and video recording features without user knowledge, leading to fears of unauthorized surveillance.

4.1.2 Lack of Transparency and Control

Participants consistently voiced frustrations regarding the lack of transparency and control over their personal information within virtual environments. X8 remarked, “I feel like I have very little control over how my data is shared and used within MR platforms. There’s often a lack of clarity about what information is being collected and who it’s being shared with. It’s unsettling to feel like my privacy is being compromised without my knowledge.” X6 highlighted, “One particular issue was the lack of transparency regarding data-sharing practices within virtual environments. This made me apprehensive about sharing personal information or engaging in certain activities, fearing that my data could be misused or exploited.”

X8 and X6 expressed their concern about the inability to control how sensitive data is collected and shared, which led to discomfort and reluctance to fully engage in MR environments.

4.1.3 Invasive Features

invasive features, such as unsanctioned audio and video recordings, emerged as a significant concern among participants. X9 recounted, “I’ve had instances where I’ve discovered audio recordings of conversations I had in MR environments without my knowledge or consent. It’s invasive and makes me question the level of privacy we have in these virtual spaces.” X1 expressed unease about video recordings in MR platforms, noting, “It’s troubling to think that my actions or conversations can be recorded and analyzed without me knowing.”

X1 and X9 highlighted concern that these invasive features not only compromise personal privacy but could also expose sensitive information to misuse or exploitation. Without robust privacy safeguards and explicit user consent mechanisms, MR platforms can unwittingly become tools for surveillance, breaching user confidentiality and autonomy.

4.1.4 Privacy Breaches and Identity Theft

The risk of privacy breaches and identity theft loomed large in participants’ narratives, fueled by concerns surrounding inadequate privacy controls and vulnerabilities in MR technologies. X5 stated, “With the increasing integration of MR technologies into our daily lives, there’s a growing risk of privacy breaches and identity theft.” X4 echoed this sentiment, adding, “The lack of robust privacy controls and security measures makes me worried about the safety of my personal information within these environments.” These concerns underscore the need for proactive measures to mitigate data breaches and safeguard user privacy in MR ecosystems.

4.1.5 Vulnerabilities to Data Breaches

Participants in MR environments are deeply concerned about potential security vulnerabilities that could expose their personal information to unauthorized parties. X2 highlighted, “One particular issue was the potential for data breaches or leaks within virtual environments due to vulnerabilities in the underlying technology. This raised concerns about the security of my personal information and the risk of exposure to malicious actors.” X3 explained, “One specific issue I encountered was the potential for unauthorized access to my device's camera and microphone while using augmented reality applications. This raised concerns about the privacy and security of my data.”. Unauthorized data collection creates vulnerabilities that can lead to breaches, exposing sensitive information to hackers and cyber-criminals.

4.1.6 Sensitive Information at Risk

Participants identified specific types of sensitive information most at risk within mixed reality (MR) environments, including financial data, personal communications, and identification details. X9 articulated, *“I’m particularly concerned about the security of my financial information and personal communications within MR platforms. I expect a high level of privacy and confidentiality in these areas, but the current state of data protection in MR environments leaves much to be desired.”* This underscores the importance of robust data protection measures to prevent unauthorized access and misuse of sensitive information.

X2 raised concerns about biometric data, stating, *“One issue I encountered was the use of biometric data for user authentication within virtual environments. This raised concerns about the security and privacy of my biometric information, prompting me to reconsider my use of such technologies.”* The risk associated with biometric identifiers like facial recognition and fingerprint scanning is significant, as they cannot be changed if compromised, posing a unique risk of identity theft or fraud.

Location tracking data is also particularly vulnerable. X8 noted, *“The idea of someone knowing my whereabouts through a mixed reality application makes me hesitant to enable location services.”* GPS tracking and location-based services can reveal users' movements and habits, potentially compromising their safety.

4.1.7 Fear of Data Misuse

The complexity of privacy settings has added to these concerns, as many controls are buried within menus, making them difficult to find and customize. X4 stated, *“The lack of transparency about data-sharing practices in virtual environments made me hesitant to share personal information or take part in certain activities, as I feared that my data could be misused or exploited.”*

4.1.8 Lack of Control Over Personal Information

Participants consistently expressed concerns about the lack of effective tools to manage how their information is shared in MR environments. X1 noted, "*Navigating privacy settings in mixed reality shouldn't feel like finding a needle in a haystack. Clear, intuitive controls are essential for user trust and engagement.*" Despite efforts to manage privacy settings proactively, many users struggle to control the distribution of their data effectively. X3 mentioned, "*This, despite efforts by many users to proactively manage their privacy, points to the need for important enhancements to be made by platforms in privacy management.*"

4.1.9 Insufficient Regulations and Protections

Participants consistently expressed concerns over the inadequacies of current laws to protect their privacy in MR environments. X10 stated, "The inadequacies of current laws to protect privacy in mixed reality environments are a consistent concern." The rapid advancement of MR technologies has outpaced existing regulations, leaving gaps that allow for the potential exploitation of personal data. X7 emphasized, "In the realm of mixed reality, clear regulations are essential to ensure transparent data-sharing practices and empower users to control their personal information effectively."

4.1.10 Security Vulnerabilities

Participants in MR environments are deeply concerned about potential security vulnerabilities that could expose their personal information to unauthorized parties. X8 mentioned, "Security vulnerabilities are a great peril to mixed-reality devices, as backdoors and bugs may cause the personal information of users to fall into the wrong hands." X5 noted, "The lack of transparency in data collection by MR applications—particularly through cameras and microphones—makes users anxious about unauthorized access and misuse."

4.2 Theme 2: Social Interactions and Privacy Implications

Participants expressed more serious concerns about social interactions in mixed reality (MR) compared to individual use. In collaborative workspaces, virtual communities, social platforms, gaming, and entertainment, individuals often have to agree to terms against their will to participate. Group dynamics can pressure users into sharing more personal information than they are comfortable with.

Here, we delve into the research findings related to social interactions and privacy implications in MR.

4.2.1 Virtual Communities and Social Platforms

Participants highlighted concerns about privacy breaches and identity theft in virtual communities and social platforms within MR environments. X10 noted,

“I’m wary of sharing personal information in virtual communities and social platforms within MR environments. There’s often a lack of transparency about how our data is being used, and I worry about the potential consequences of it falling into the wrong hands.”

4.2.2 Collaborative Workspaces

In MR platforms, participants are often required to share personal information to comply with company policies and interact with others in virtual events and meetups. X4 explained, *“It is common for companies to have policies that require employees to share certain personal information to join groups and work teams. These policies are put in place to ensure effective collaboration and communication among team members.”*

This requirement can be problematic for individuals who need to keep sensitive data confidential. Peer pressure can compel individuals to disclose more personal information to conform to group norms.

4.2.3 Gaming and Entertainment

In MR gaming and entertainment, participants were concerned about data profiling and location tracking. X6 mentioned, *“As a gamer, I’m concerned about how my data is being used for profiling and targeted advertising within MR gaming environments. The integration of social media accounts only adds to the complexity of privacy issues, and I worry about the implications for my personal information.”*

Social dynamics in MR gaming can push players to share personal information due to peer pressure. X3 noted, *“Navigating privacy in MR gaming is challenging, as the desire to foster camaraderie can push individuals to share personal stories and contact details.”*

These concerns highlight the need for enhanced privacy protections and clearer guidelines within MR gaming environments to address data profiling, location tracking, and social pressures.

5. Discussion

This chapter synthesizes the findings from our exploration of privacy concerns within Mixed Reality (MR) environments, building upon the nuanced user experiences, situational factors, and technological interactions previously detailed. By examining how individuals navigate privacy within these immersive spaces, we anchor our empirical findings within broader theoretical frameworks and practical implications, ensuring a comprehensive discourse that spans both individual and systemic privacy concerns.

We revisit the theoretical foundations laid in earlier chapters to deepen the understanding of these dynamics and assess their implications for future research and the continued development of MR technologies. Additionally, we identify limitations within our study and propose future investigative paths that could enhance the understanding of privacy as digital integration progresses. Ultimately, this discussion aims to offer a thorough analysis that not only connects individual experiences to systemic issues but also provides actionable insights that could inform both policy and practice in the field of Mixed Reality.

5.1 Methods, implementation, and results

This study provides an extensive exploration of privacy concerns in mixed reality (MR) environments, uncovering several themes that enhance our understanding of how users perceive privacy within these immersive contexts. Through semi-structured interviews and thematic analysis, we identified key concerns including unauthorized data collection, lack of transparency, invasive features, privacy breaches, and the unique risks posed to sensitive information.

One of the central themes identified in the analysis is the issue of unauthorized data collection. Participants expressed significant concerns about personal data being collected without clear consent, including biometric data, location tracking, and unsanctioned access to device cameras and microphones. This finding resonates with existing literature on privacy in digital environments, highlighting the pervasive anxieties surrounding data privacy and surveillance in the digital age.

Another prominent theme is the lack of transparency and control over personal information within virtual environments. Participants expressed apprehension about data misuse due to a lack of transparency in data-sharing practices and insufficient control over how their personal information is collected, stored, and shared. This lack of control undermines users' trust in MR technologies and raises important questions about the ethical and legal implications of data collection and processing in virtual spaces.

Invasive features, such as unsanctioned audio and video recordings, also emerged as a significant concern among participants. Users expressed unease about being recorded without their knowledge or consent, highlighting the potential privacy risks associated with immersive virtual experiences. This finding underscores the importance of incorporating privacy-by-design principles into

the development of MR technologies to mitigate the risk of invasive features and protect user privacy.

Privacy breaches and identity theft were identified as additional concerns, particularly within virtual communities or platforms where users may share personal information without adequate privacy controls. Participants expressed fears about the unauthorized sharing of personal information and the potential consequences of identity theft and unauthorized access. This finding underscores the need for robust security measures and clear data management policies to safeguard user privacy in MR environments.

The study also revealed how privacy concerns vary across different social interactions within mixed-reality environments, including virtual communities, collaborative workspaces, and gaming and entertainment platforms. Participants expressed varying levels of concern depending on the context of their interactions, highlighting the need for tailored privacy solutions that take into account the specific dynamics of each social setting.

By integrating qualitative insights into theoretical frameworks, this research contributes to a deeper understanding of privacy in MR technologies, advocating for enhanced privacy considerations in their design and regulatory frameworks.

5.2 Previous Research

The findings of this study shed light on several key aspects of privacy concerns in mixed reality (MR) environments, aligning closely with prior research while also uncovering new insights. In analyzing the data collected through semi-structured interviews and thematic analysis, it becomes evident that users express significant apprehensions regarding unauthorized data collection, lack of transparency and control over personal information, and the potential impact of social interactions on privacy.

Comparative analysis of the research on the Internet of Things (IoT) by Ali Padyab and Anna Ståhlbröst reveals parallel challenges. Both studies identify the critical need for enhanced privacy measures, but each focuses on distinct aspects of how privacy is managed within their respective frameworks. For IoT, concerns center around data collection, storage, and device security, often eluding user detection or consent. For MR, privacy issues extend into the immersive experience, amplifying the potential for unauthorized access and lack of control due to the blended nature of physical and virtual realities.

Both fields underscore the importance of user-centered design and policy measures to improve transparency and control for users. These studies advocate for better communication with users about data practices and emphasize the need to incorporate user feedback into the design and regulatory processes. Despite their technological differences—IoT being largely about connectivity and MR being about immersive experiences—the core concerns about privacy control, transparency, and the influence of context on privacy dynamics are strikingly similar.

The thesis further discusses "Security and Privacy Approaches in Mixed Reality: A Literature Survey" by De Guzman et al. (2019), which highlights the rapid advancement of MR technologies and the lag in developing adequate security and privacy protections. The survey provides a technical overview, suggesting strategies to safeguard MR environments against potential breaches and stressing the necessity of early integration of these protections.

In contrast, this thesis takes a user-centric approach, delving deep into how individuals perceive and navigate privacy within MR environments. The insights from MR users about data security, unauthorized access, and privacy control, especially in social interactions, add a nuanced layer to our understanding and are instrumental in shaping recommendations for privacy-aware MR system design.

Together, these studies paint a comprehensive picture of the privacy and security landscape in MR, suggesting a multifaceted approach to addressing these concerns and calling for a paradigm shift towards more empathetic and user-informed development practices in emerging technologies.

5.3 Ethical and Societal Aspects

In discussing the social and ethical aspects related to "Exploring Individual Privacy Concerns in Mixed Reality Use Situations," several crucial points emerge.

5.3.1 Social Aspects

- **User Trust and Social Dynamics:** Mixed Reality (MR) environments create a space where physical and virtual realities blend, leading to unique social dynamics. Trust becomes a critical factor as users navigate these environments, interacting with both real and virtual entities. Users' perceptions of privacy in MR affect their willingness to engage deeply with the technology, potentially impacting social interactions and community building within these digital spaces.
- **Influence on Social Behavior and Interaction:** MR technologies can significantly influence social behavior and interactions. For example, collaborative MR applications like virtual workspaces or social platforms can change traditional communication patterns, creating new forms of social engagement but also raising concerns about over-surveillance and behavioral tracking.
- **Digital Divide and Accessibility:** The adoption of MR technologies can exacerbate existing social inequalities. Access to these technologies is not uniform, potentially leading to a digital divide where only certain segments of the population benefit from the advanced capabilities of MR, such as enhanced learning environments or innovative work tools.

5.3.2 Ethical Aspects

- **Privacy Concerns:** The ethical implications of privacy in MR are paramount. As MR collects extensive amounts of personal data, including biometric and locational data, it raises significant concerns about user consent, data security, and the potential for misuse of this information. Ensuring that MR applications have robust privacy protections and transparent data handling practices is crucial.
- **Data Security and User Autonomy:** Ethical development and deployment of MR technologies must prioritize data security to protect users from potential breaches that could expose sensitive information. Moreover, ethical considerations should ensure that users maintain autonomy over their digital personas and the content they create or interact with in MR settings.
- **Regulatory and Legal Implications:** There is a need for clear regulatory frameworks that address the rapid advancements in MR technology. Ethical governance should guide the development of laws and regulations that protect users while fostering innovation. Legal standards must evolve to tackle the nuanced challenges posed by MR, such as intellectual property concerns in digital creations and the right to digital privacy.

5.4 Implications for Theory and Practice

The findings of this study have several implications for both theoretical frameworks and practical interventions aimed at addressing privacy concerns in mixed reality environments. From a theoretical perspective, the identification of recurring themes such as unauthorized data collection and lack of control over personal information contributes to the refinement of existing models of privacy behavior and decision-making in virtual contexts (Braun & Clarke, 2006). Integrating insights from qualitative research into theoretical frameworks can enhance their explanatory power and predictive validity, providing a more nuanced understanding of privacy dynamics in MR.

On a practical level, the findings underscore the urgent need for developers, policymakers, and users to prioritize privacy considerations in the design and implementation of MR technologies (Bell et al., 2022). Strategies for enhancing transparency, empowering users with greater control over their data, and implementing robust security measures are essential for mitigating privacy risks in immersive environments (Bryman et al., 2022). Furthermore, fostering a culture of privacy awareness and digital literacy among MR users can help mitigate the impact of privacy breaches and empower individuals to make informed decisions about their online presence (Kallio et al., 2016).

5.5 Addressing Research Questions and Objectives

The findings of this study effectively address the research questions and objectives outlined at the outset of the research. Through semi-structured interviews and thematic analysis, the study successfully explored the experiences, perceptions, and concerns of MR users regarding privacy in virtual environments. By identifying key themes such as unauthorized data collection, lack of transparency, and the impact of social interactions on privacy, the study provides meaningful insights into the complex dynamics of privacy in MR.

Furthermore, the integration of NVivo software for data analysis facilitated a rigorous and systematic examination of the qualitative data, ensuring the reliability and validity of the findings. The research process adhered to ethical guidelines and standards, demonstrating a commitment to upholding participant confidentiality and ensuring the integrity of the research process.

5.6 Limitations

Despite the valuable insights generated by this study, it is essential to acknowledge its limitations and identify areas for future research. One limitation is the relatively small sample size of participants, which may limit the generalizability of the findings. Future research could benefit from larger and more diverse samples to capture a broader range of perspectives and experiences.

Additionally, the study focused primarily on user perspectives, neglecting the viewpoints of MR developers, policymakers, and other stakeholders. Future research could adopt a multi-stakeholder approach to explore how different actors perceive and address privacy concerns in MR environments.

Furthermore, the study predominantly utilized semi-structured interviews as the primary data collection method. Incorporating complementary methods such as participant observation or document analysis could provide additional context and deepen our understanding of privacy dynamics in MR.

6. Conclusion

In this study, we explored the complex landscape of privacy concerns in mixed reality (MR) environments, revealing the multifaceted nature of data protection, transparency, and user control. Our research findings underscore the importance of transparency, control, and security in safeguarding user privacy in immersive virtual spaces, as evidenced by participants' experiences and perceptions. We identified key themes through meticulous analysis of semi-structured interviews and thematic exploration, highlighting the pervasive apprehensions surrounding unauthorized data collection, lack of transparency, and vulnerabilities to privacy breaches. Addressing these concerns requires a collaborative effort from developers, policymakers, and users to prioritize privacy considerations in designing, implementing, and regulating MR technologies. By examining these issues within the context of diverse social interactions in MR, including virtual communities, collaborative workspaces, and gaming platforms, our research provides insight into the nuances and challenges inherent in preserving privacy in immersive digital environments. Integrating insights from qualitative research into theoretical frameworks and practical interventions can help stakeholders create safer and more privacy-respecting virtual environments for all users.

The research findings presented in this study provide valuable insights into privacy concerns in mixed reality (MR) environments. Through semi-structured interviews and thematic analysis, several key themes emerged. Participants expressed significant concerns about unauthorized data collection, including biometric data, location tracking, and unsanctioned access to device cameras and microphones. A lack of transparency in data-sharing practices and insufficient control over personal information within virtual environments led to apprehension about data misuse among participants. Users were uneasy about audio and video recordings made within virtual environments without their knowledge or consent, raising serious privacy concerns.

Fears about the sharing of personal information within virtual communities or platforms without adequate privacy controls were prevalent, leading to concerns about identity theft and unauthorized access. Additionally, concerns about data breaches or leaks due to vulnerabilities in MR technologies were raised, highlighting the risk of personal information being accessed by malicious actors. Participants also identified particularly vulnerable personal information, including location data, biometric data, personal communications, financial information, and identification details. Furthermore, the study revealed how these concerns varied across different social interactions within mixed-reality environments, including virtual communities, collaborative workspaces, and gaming and entertainment platforms.

These findings contribute to existing knowledge by highlighting the complexities of privacy dynamics in MR environments. The study enriches theoretical frameworks by providing empirical evidence of privacy concerns and behaviors in virtual contexts. It also emphasizes the need for developers, policymakers, and users to prioritize privacy considerations and implement strategies to mitigate privacy risks in MR technologies.

The research process involved rigorous data collection and analysis methods, including semi-structured interviews and thematic analysis. The integration of NVivo software enhanced the efficiency and depth of qualitative analysis. Ethical considerations were paramount throughout the research process, ensuring participant confidentiality and upholding the integrity of the study.

6.1 Future Work

Future research could expand our understanding further by incorporating diverse participant groups, including MR developers, policymakers, and various stakeholders. This could offer a comprehensive view of privacy dynamics and strategies for addressing them. Comparative studies across different demographics and cultural contexts could illuminate variations in privacy perceptions and behaviors, guiding tailored privacy management strategies.

Longitudinal research would be instrumental in tracking privacy attitudes over time, particularly as MR technologies evolve and integrate more deeply into daily life. This approach could highlight emerging trends and the long-term effectiveness of privacy policies.

Exploring the intersection of privacy concerns with factors like trust, usability, and user experience could yield a more holistic model of user behavior in MR. Additionally, investigating how emerging technologies such as artificial intelligence and blockchain could fortify privacy protections may open new avenues for innovation.

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Appendix A- Interview Template

Actions before the interview

1. Brief introduction of the interviewer and the study purpose.
2. Explanation of the interview process, estimated duration, and confidentiality measures.
3. Obtain verbal consent to proceed with the interview and record responses.

Questions

Section 1: Background Information

1. Can you describe your experience with mixed reality technologies and how frequently you engage with them in various contexts?

Follow-up Question: Could you provide examples of specific contexts or situations where you find yourself most frequently utilizing mixed reality technologies, and how does your usage vary across these different contexts?

2. What are some of the main reasons you use mixed reality applications or platforms?

Follow-up Question: Can you elaborate on specific tasks or activities that you find particularly well-suited for mixed reality applications or platforms, and how do these reasons influence your choice of using them?

Section 2: Privacy Concerns and Experiences

1. Have you ever encountered any privacy-related issues or concerns while using mixed reality technologies? If so, could you describe them?

Follow-up Question: How did you address or attempt to mitigate the privacy-related issues or concerns you encountered while using mixed reality technologies?

2. What personal information do you feel is most at risk or vulnerable when using mixed reality applications or platforms?

Follow-up Question: In your opinion, what measures or safeguards could be implemented to better protect the personal information you've identified as most at risk in mixed reality environments?

3. Can you recall a specific instance where you felt uncomfortable or hesitant about sharing personal information while using mixed reality?

Follow-up Question: What factors contributed to your discomfort or hesitation in that particular instance, and how did you navigate the situation?

4. Are there specific features or functionalities within mixed reality applications that you believe pose greater privacy risks?

Follow-up Question: How do you think developers or companies could address these potential privacy risks associated with specific features or functionalities in mixed reality applications?

5. How do you manage your privacy settings or preferences when using mixed reality technologies? Do you feel that you have adequate control over your personal information?

Follow-up Question: Have you encountered any challenges or limitations in adjusting your privacy settings in mixed reality applications, and if so, how have you dealt with them?

6. Have you ever adjusted your behavior or interactions within mixed reality environments due to privacy concerns? If so, in what ways?

Follow-up Question: Could you provide examples of specific changes you've made to your behavior or interactions in mixed reality environments to address privacy concerns, and how effective do you feel these adjustments were?

Section 3: Social Interactions and Privacy

1. Do you perceive any differences in privacy concerns when using mixed reality applications for solo experiences compared to social interactions within mixed reality environments?

Follow-up Question: How do you adapt your privacy practices or behaviors when transitioning between solo experiences and social interactions within mixed reality, and what factors influence these adaptations?

2. Can you describe any instances where social interactions within mixed reality environments have influenced your privacy concerns or behaviors?

Follow-up Question: How did you navigate or address the privacy concerns that arose from social interactions within mixed reality environments, and what lessons did you learn from those experiences?

3. How do you think social factors such as peer pressure or group dynamics impact individuals' privacy perceptions and behaviors in mixed reality contexts?

Follow-up Question: In your opinion, what strategies or approaches could be employed to mitigate the influence of social factors on individuals' privacy perceptions and behaviors within mixed reality environments?

4. Can you recall a specific instance where your privacy concerns were influenced by interactions with others in a mixed reality setting? If so, what were the circumstances?

Follow-up Question: Reflecting on that specific instance, how do you think the presence of others in the mixed reality environment contributed to your privacy concerns, and what steps did you take to address them?

5. How do your privacy concerns differ when engaging in social interactions within mixed reality environments compared to solo experiences?

Follow-up Question: Can you provide examples of specific privacy concerns that are unique to social interactions within mixed reality environments, and how do you prioritize addressing them?

6. In your opinion, what are the main challenges or risks associated with sharing personal information during social interactions within mixed reality environments?

Follow-up Question: How do you think these challenges or risks could be effectively managed or minimized by developers or platform providers to enhance user privacy and security in mixed-reality social interactions?

7. Have you ever felt pressure to disclose personal information or participate in activities within mixed reality environments due to social dynamics or expectations? If yes, could you elaborate on the experience?

Follow-up Question: Looking back on that experience, how did you handle the pressure to disclose personal information, and what strategies would you recommend to others facing similar situations in mixed reality environments?

Appendix B- Email Template

Subject: Invitation to Participate in Research Interview on Mixed Reality Privacy Concerns

Dear [Recipient's Name],

I hope this email finds you well. My name is Hiwa Ahmed, and I am a master's student in Informatics, specializing in Data Science/Privacy, Information, and Cyber Security. Currently, I am researching "Exploring Individual Privacy Concerns in Mixed Reality Use Situations." As someone who has experience and expertise in mixed reality (MR), your insights and perspectives are invaluable to my research. Therefore, I would like to invite you to participate in a research interview where you can share your valuable input and experiences regarding privacy concerns in mixed reality environments.

Research Focus:

My research aims to gain a deeper understanding of the privacy dynamics within mixed reality (MR) environments, particularly focusing on how individuals perceive and navigate privacy concerns during their interactions with MR technologies.

Interview Details:

- **Method of Communication:** Remote (via [preferred communication method])
- **Duration:** Approximately [The decision is yours] minutes
- **Date and Time:** We can schedule the interview at your convenience. Please let me know your availability, and I will do my best to accommodate it.
- **Confidentiality:** All information provided during the interview will be kept strictly confidential, and your identity will remain anonymous in any reporting or publication of findings.

Your Participation:

Participation in this research interview would involve sharing your experiences, insights, and concerns about privacy in mixed reality use situations. Your input will play a vital role in shaping this study's outcomes and contributing to advancing knowledge in this field.

Preferred Communication Method:

Please let me know your preferred method of communication for the interview, ensuring that it aligns with your company's policies and guidelines.

Next Steps:

If you are interested in participating, please reply to this email with your preferred date and time for the interview, as well as your preferred communication

method. Additionally, if you have any questions or concerns regarding the research or interview process, feel free to reach out to me. Thank you for considering this invitation, and I look forward to the opportunity to collaborate with you on this research endeavor.

Best regards,

Hiwa Ahmed
Master's Student in Informatics
University of Skövde /Sweden

Appendix C- License

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