

From Immersion to Manipulation: Exploring the Prevalence of Dark Patterns in Mixed Reality

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Abstract

The continuing advances in Mixed Reality (MR) technology have finally brought MR experiences to the consumers. However, the growing number of experiences merging the physical and virtual worlds has also elicited a rise in the use of dark patterns and manipulative design tactics intended to deceive users into actions they might not otherwise take. This preliminary research investigates the mechanisms and prevalence of dark patterns in MR environments, providing a first glimpse into manipulative practices. Analyzing 80 MR applications across various MR platforms, we identified five primary dark patterns: Hidden Costs, Misinformation, Button Camouflage, Forced Continuity, and Disguised Ads. Our ongoing analysis highlights the impact of these patterns on user trust and decision-making.

1 Introduction and Background

Mixed Reality (MR) technology rapidly evolves, providing immersive experiences by blending the physical and virtual worlds. Finally, consumer devices are available, and users can experience MR applications in various domains, such as gaming, entertainment, education, or shopping. At the same time, this trend causes new threats to individuals' privacy and security. One critical concern is the increasing presence of dark patterns – design strategies that manipulate users into making decisions against their best interests. As MR becomes more integrated, understanding and mitigating these deceptive practices is crucial to ensure user independence and trust in these advanced technologies [3].

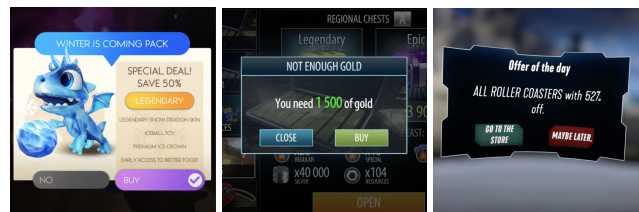


Figure 1: We analyzed the prevalence of dark patterns across 80 applications on various Mixed Reality platforms. Patterns include button camouflage (left), hidden costs (center), or false urgency (right).

Prior research has primarily focused on identifying and categorizing dark patterns in conventional interfaces, highlighting these patterns' ethical and practical concerns. Recently, research has started exploring the possibilities and implications of tricking users by facilitating MR technology. To that end, Egtebas et al. [2] utilized speculative design to explore deceptive design scenarios that may arise with pervasive MR. According to their research, potential future harms and risks could be caused by the situatedness of information, altering human perception, and the inherent ubiquity of sensing.

Similarly, Krauss et al. [5] investigated dark patterns in MR through expert co-design workshops. Based on several co-designed scenarios, they specified novel and confirmed existing dark patterns. Given the unique technological properties of MR, they concluded that specific dark patterns could be amplified by exploiting MR properties such as spatiality and perception, leading to less effective traditional mitigation strategies.

While these scenarios are speculative, they may not represent actual future uses of MR. Going beyond speculation and co-design, Wang et al. [6] developed the first mockups to study the effects of dark patterns in MR. They showcased that dark patterns can be effectively facilitated in immersive scenarios. Despite understanding the unique challenges and malicious potential posed by the immersive qualities of MR technology that can amplify the effect of dark patterns [4],

there remains a gap in understanding the prevalence of dark patterns in current MR applications.

This research aims to fill the gap by preliminarily assessing *how prevalent dark patterns are in Mixed Reality applications across major platforms*. Furthermore, through a systematic onboarding and walkthrough of available applications, we elaborate on *which specific manipulative techniques are most commonly employed to influence user behavior*.

2 Methodology

Our preliminary analysis involved a systematic, user-centric approach to identify and analyze dark patterns in MR applications. Initially, MR applications were installed and explored from a regular user’s perspective, including potential registration, onboarding, and thorough exploration of the key features or gameplay. During exploration, we logged occurrences of dark patterns, paying particular attention to user interface layout, screen transitions, and signs of persuasion or deception. Criteria for identifying dark patterns include deceptive user experience designs specified by Brignull et al. [1] and recent speculative designs [2, 5].

Application Selection: Our investigation focuses on four major platforms providing MR applications for handheld or head-worn MR devices: the Play Store (Google), App Store (Apple), Horizon Store (Meta), and Microsoft Store (Microsoft). For each platform, we selected MR applications that met three criteria: (1) availability, (2) free of charge for download, and (3) trending in the respective VR/AR/MR category. We installed and sampled the applications on a Pixel 8 (Google), iPhone 13 (Apple), Quest 3 (Meta), and HoloLens 2 (Microsoft). We selected 20 MR applications from each platform, resulting in 80 applications. We selected and analyzed the applications between January and March 2024.

3 Results and Discussion

Our preliminary analysis of the 80 selected MR applications revealed five leading dark patterns: *Hidden Costs* (unexpected charges revealed during application use), *Misinformation* (presentation of false or misleading information), *Button Camouflage* (tricking users into clicking more prominent buttons), *Forced Continuity* (lack of straightforward and easy options to cancel subscription), and *Disguised Ads* (advertisements designed like regular content or interface elements). Disguised Ads emerged as the most prevalent pattern, mainly aimed at financial gain through persistent advertising. Further, we identified that dark patterns often co-occur, with Hidden Costs frequently leading to Misinformation.

Interestingly, our analysis found variations in the prevalence of dark patterns across the different platforms. For example, the Horizon Store heavily featured Forced Continuity

and Disguised Ads, while Play Store applications often included Hidden Costs and Button Camouflage. We further found manipulative practices in MR applications, exploiting user psychology through strategic placement of buttons, ambiguous messaging, and manipulation of default choices.

Our preliminary results already highlight the pervasive use of dark patterns in free MR applications across major platforms. Disguised Ads, being the most prevalent, emphasize prioritizing financial gain over user experience. Yet, this finding might be influenced by the application selection process and calls for further analysis. The identified patterns pose ethical concerns and call for regulatory measures to safeguard users. Countermeasures or advanced mitigation strategies are particularly of greater interest given the current research and speculations on the future development of dark patterns toward ubiquitous MR.

While our dataset is small (in contrast to the number of available applications) and has certain limitations, our preliminary analysis shows already today that MR applications exploit cognitive biases and psychological weaknesses to deceive or manipulate users’ actions intentionally.

Future empirical studies and in-depth analyses are necessary to understand the development of dark patterns on different platforms and to monitor past and future changes. We argue for developing a standardized method to identify, analyze, and categorize manipulative practices consistently. Establishing a framework will facilitate comprehensive cross-platform comparisons and contribute to developing best practices for ethical design to build trust in MR technology and ultimately enable the community to create adapted mitigation strategies over time.

4 Conclusion and Future Work

Our preliminary study reveals the extensive use of dark patterns in MR applications across major platforms. We identified five primary dark patterns: Hidden Costs, Misinformation, Button Camouflage, Forced Continuity, and Disguised Ads. The prevalence of these manipulative designs, especially Disguised Ads, underscores ethical concerns, highlights the need for regulatory measures, and calls for further research. Addressing these challenges is crucial to ensuring user trust and ethical design practices in MR environments.

We argue for further analysis to deepen the understanding of current and future dark pattern dynamics in MR environments. With this work, we plan to discuss further the necessity of anticipating the potential risks to users’ privacy and security, gain valuable feedback from the research community during the conference, and motivate new approaches to mitigate dark patterns in MR environments.

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