Approaches and Theoretical Models in the Evaluation of XR Technologies Acceptance

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Abstract: Extended Reality (XR) technologies, encompassing Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), have seen rapid advancement and widespread adoption across various domains, including education, healthcare, entertainment and industry. Evaluating these technologies is crucial for understanding their usability, user experience, performance and overall effectiveness. This article provides a comprehensive review of the current approaches and theoretical models employed in the evaluation of XR technologies. The evaluation approaches discussed include usability evaluation, which focuses on the ease of use and user satisfaction through methods such as user testing and heuristic evaluation; user experience (UX) evaluation, which assesses the holistic experience of users using questionnaires, interviews and focus groups; and performance evaluation, which measures task efficiency and error rates to determine the effectiveness of XR systems.
Keywords: Acceptance Evaluation, Extended Reality, Theoretical Models, User Experience (UX).

INTRODUCTION

Extended Reality (XR) technologies, have emerged as transformative tools with applications spanning education, healthcare, entertainment and industry. XR technologies refer to a spectrum of immersive technologies that extend reality by integrating virtual and physical worlds. VR immerses users in entirely virtual environments through headsets or other devices, enabling interactive experiences that simulate real-life scenarios. AR overlays digital information onto the user's view of the real world, enhancing perception and interaction. MR combines elements of both VR and AR, allowing users to interact with digital content in real-time within their physical environment. The rapid evolution and adoption of XR have sparked significant interest in understanding their impact and effectiveness.

As XR technologies continue to evolve, their successful integration and adoption hinge on effective evaluation methods. Evaluating XR technologies serves multiple purposes:

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assessing usability to ensure intuitive interaction, evaluating user experience to enhance satisfaction and engagement, measuring performance metrics to gauge efficiency and effectiveness, and validating theoretical models to understand user behavior and acceptance.

In addition to practical evaluation approaches, the article explores key theoretical models that provide a deeper understanding of user interactions with XR technologies. The Technology Acceptance Model (TAM) examines factors influencing user acceptance and intention to use XR systems. The Task-Technology Fit (TTF) model assesses the alignment between task requirements and technological capabilities, predicting performance outcomes. Flow Theory explores the optimal psychological state achieved when users engage with XR environments, balancing challenge, and skill to enhance user engagement and satisfaction.

By integrating these approaches and models, the article highlights best practices and case studies that illustrate successful evaluation strategies. The discussion extends to emerging trends and future directions in XR evaluation, addressing the need for innovative methods and theoretical advancements to keep pace with the evolving XR landscape. This comprehensive review underscores the importance of rigorous evaluation in advancing XR technologies, ensuring they meet user needs and achieve their intended impact across various applications.

EVALUATION APPROACHES IN XR TECHNOLOGIES

Evaluation approaches in Extended Reality (XR) technologies are essential for assessing their usability, user experience, and performance. These approaches provide valuable insights into how well XR systems meet user needs, enhance engagement, and achieve intended outcomes across various applications. The most well-known approaches in evaluating of XR technologies are: usability evaluation, user experience evaluation, performance evaluation and acceptance evaluation.

Acceptance Evaluation

The acceptance of Extended Reality (XR) technologies is critical for their successful adoption and integration into various domains such as education, healthcare, and entertainment. These technologies have gained significant popularity due to their ability to offer immersive, interactive experiences that blend the physical and digital worlds. However, for XR technologies to become widely spread, both individual users and organizations must perceive clear benefits and ease of use in real-world applications.

One of the primary factors driving XR technology acceptance is its perceived utility across diverse sectors. In fields such as healthcare, XR technologies are being used for advanced simulations and medical training, while in education, they provide immersive learning experiences that engage students in new and interactive ways. Similarly, industries like retail and manufacturing are adopting XR to enhance customer engagement and improve operational efficiency (Müller et al., 2020). The ability of XR technologies to meet specific needs and improve processes has been crucial in their increasing acceptance.

Another significant element influencing XR acceptance is the technology's usability and user experience. Since XR systems often require specialized hardware, such as headsets or controllers, the ease with which users can adopt and interact with these systems is crucial. The design of intuitive interfaces and seamless interaction methods is essential to reducing the learning curve and ensuring that users feel comfortable and satisfied with the technology.

Furthermore, societal trends and cultural attitudes towards technology adoption also play a role in the acceptance of XR. As these technologies become more prevalent, especially in gaming and entertainment, societal norms and peer influence can contribute to greater willingness among individuals and organizations to adopt XR systems. In particular, the younger generation, which is more familiar with digital and interactive technologies, tends to embrace XR more rapidly, further driving its acceptance and adoption.

Usability Evaluation

Usability evaluation focuses on the effectiveness, efficiency, and satisfaction with which users can achieve tasks in XR environments. It aims to identify usability issues and optimize user interfaces to improve user interaction and experience. Common methods employed in usability evaluation include user testing, heuristic evaluation, and cognitive walkthroughs.

User testing involves observing users as they perform tasks in XR environments, noting their interactions, difficulties encountered, and feedback provided. This method helps identify usability issues and areas for improvement. Recent studies highlight the importance of user testing in VR educational applications to improve navigation and interaction design (Freina & Ott, 2015).

Heuristic evaluation utilizes usability principles or heuristics to evaluate XR interfaces for compliance and potential usability problems. Experts analyze XR applications based on established guidelines and identify usability issues independently. (Sutcliffe & Gault, 2004) emphasize that heuristic evaluation can reveal critical usability flaws in VR systems.

Cognitive walkthroughs involve step-by-step analysis of how users accomplish tasks in XR environments, focusing on their decision-making processes and interactions with the system. This method helps assess the cognitive load and intuitiveness of XR interfaces. A recent study by (Hartson et al., 2018) demonstrates the effectiveness of cognitive walkthroughs in identifying usability issues in AR applications.

For example, studies have applied heuristic evaluation to assess the usability of VR interfaces in educational settings, identifying navigation challenges and interface design flaws that hindered user interaction (Bowman et al., 2002).

User Experience (UX) Evaluation

UX evaluation in XR focuses on understanding the holistic experience of users, encompassing their perceptions, emotions, and satisfaction with the immersive environment.

This approach aims to optimize XR applications to meet user expectations and enhance overall experience. Common methods include questionnaires, interviews and focus groups.

Questionnaires involve surveys designed to capture user perceptions of the XR experience, assessing factors such as enjoyment, engagement, presence, and perceived usefulness. The User Experience Questionnaire (UEQ) has been adapted for XR environments to measure these factors effectively (Schrepp et al., 2017).

Interviews and focus groups are qualitative methods that gather in-depth feedback from users about their experiences with XR technologies, exploring their thoughts, emotions, and suggestions for improvement. Focus groups have been particularly effective in gathering user insights for VR training applications in healthcare. For instance, (Laugwitz et al., 2008) developed and evaluated a user experience questionnaire specifically tailored for VR applications, providing insights into usability, hedonic quality, and stimulation of the immersive experience.

Performance Evaluation

Performance evaluation in XR assesses the efficiency and effectiveness with which users accomplish tasks within virtual or augmented environments. It focuses on objective metrics such as task completion time, accuracy, error rates, and cognitive workload. Key methods include task performance metrics and efficiency metrics.

Task performance metrics are quantitative measures of user performance in XR tasks, including speed, accuracy, and completeness of tasks performed within the virtual environment. Research shows that AR can significantly improve task performance in industrial settings (Müller et al., 2020).

Efficiency Metrics focuses on assessments of how efficiently users navigate XR interfaces and accomplish tasks, considering factors such as navigation paths, interaction times, and cognitive demands.

For example, studies have applied performance evaluation techniques to measure the impact of AR overlays on assembly tasks in industrial settings, demonstrating improvements in task completion time and accuracy (Billinghurst et al., 2001).

THEORETICAL MODELS IN THE ACCEPTANCE EVALUATION OF XR TECHNOLOGIES

The evaluation of Extended Reality (XR) technologies benefits significantly from theoretical models that provide frameworks for understanding user behaviors, acceptance, and performance within immersive environments. Technology acceptance models help to develop a solid theoretical framework for the creation of research models through which the acceptance of technologies and systems can be properly demonstrated. These models help researchers and practitioners analyze the factors influencing user interaction with XR systems and predict their outcomes.

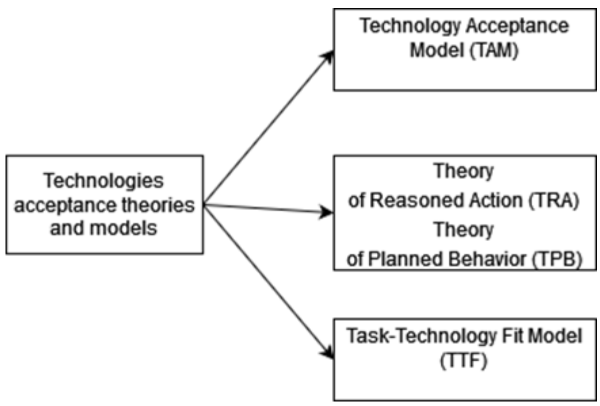

Figure 1. *Commonly used theories and models in the acceptance of XR technologies*

Theories and models of technology acceptance are commonly applied in researches exploring the factors that drive the adoption and use of new technologies.

While each theory or model offers unique principles and benefits, they also work together in a complementary manner. The advancement of these models has been largely shaped by findings from fields such as psychology, sociology and information technology.

The most influential among these are the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), and the Task-Technology Fit (TTF) Model. These models offer valuable insights into the cognitive and social processes that drive technology adoption and are widely used in the study of XR technologies. Next, the variables of each acceptance model will be analyzed in detail, as well as the relationships between them.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a widely used theoretical framework in the evaluation of technology adoption and use, including XR technologies. TAM is an adaptation of the theory of motivated action (TRA) to the field of information systems (Davis, 1989). TAM posits that user acceptance and adoption of technology are determined by two primary factors: perceived usefulness (PU) and perceived ease of use (PEOU).

- Perceived Usefulness (PU) refers to the extent to which a user believes that using XR technologies will enhance their performance or productivity in achieving specific tasks or goals.
- Perceived Ease of Use (PEOU) refers to the degree to which a user perceives that using XR technologies will be free of effort or complexity.

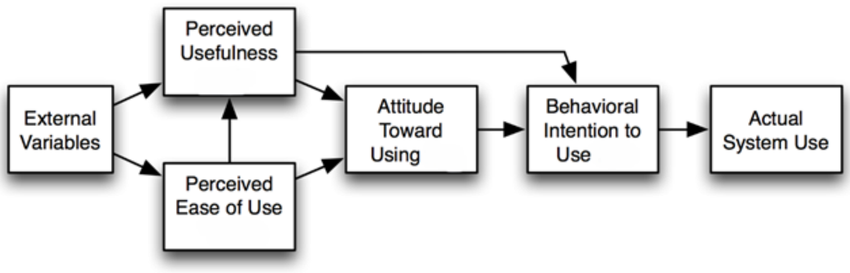

Figure 2. *Technology Acceptance Model (TAM) (adapted from Davis et al., 1989)*

The direct relationship between perceived usefulness and intention shows that people form their behavioral intentions to use based on their cognitive appraisal of how using the system will contribute to improving their performance. According to TAM, users are more likely to accept and use XR technologies if they perceive them to be useful and easy to use. Researchers apply TAM to evaluate user acceptance and intention to use XR systems across various domains, such as healthcare, education, and entertainment.

For example, (Davis, 1989) originally proposed TAM to explain user acceptance of information technology and has been adapted and applied to study user acceptance of technology applications in different contexts. Recent studies also applied TAM to assess the acceptance of VR in educational settings, finding significant correlations between perceived ease of use, perceived usefulness, and user acceptance (Huang et al., 2016). Also, a study by (Venkatesh & Bala, 2008) applied TAM to assess the acceptance of VR in educational fields, demonstrating significant correlations between perceived ease of use, perceived usefulness, and user acceptance.

The Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) is one of the foundational models for understanding human behavior in various contexts, including technology adoption. The authors of this theory start from the hypothesis that individuals are rational and systematically use available information to undertake an action. Before engaging or not engaging in a certain behavior, individuals consider the implications of their actions (Ajzen, 1991).

According to TRA, an individual's behavioral intention is determined by two factors:

- Attitude Toward the Behavior - the individual's positive or negative feelings about performing the behavior.
- Subjective Norms - the individual's perception of whether important others (e.g., friends, family, colleagues) think they should perform the behavior.

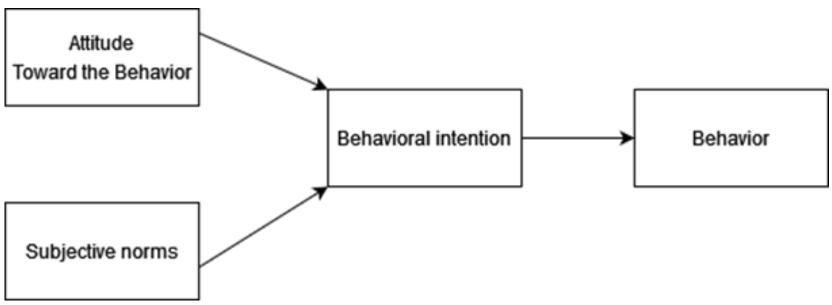

Figure 3. *The Theory of Reasoned Action (TRA) (Source: Fishbein & Ajzen, 1975)*

TRA has been applied in XR technology research to understand how users form intentions to use XR systems based on their attitudes and the influence of social norms. For example, a study by (Fishbein & Ajzen, 1975) on the adoption of VR for educational purposes found that both attitudes toward VR and the influence of peers and educators significantly impact students' intentions to use VR technology in their studies.

The Theory of Reasoned Action (TRA) has also been effectively applied in the evaluation of XR technologies. A study by (Verhagen et al., 2014) applied TRA to understand how consumers' attitudes toward VR and the influence of peers impacted their intention to use VR for online shopping. Results showed that both positive attitudes and social norms were crucial in predicting VR shopping adoption. Also, the study of (Rauschnabel et al., 2016) applied TRA to examine the factors affecting the adoption of augmented reality (AR) for marketing purposes. The research highlighted that attitudes toward the use of AR in marketing campaigns and subjective norms significantly influenced marketing professionals' intentions to adopt AR technologies.

The Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) extends the Theory of Reasoned Action (TRA) by adding the concept of perceived behavioral control, which reflects the ease or difficulty of performing the behavior in question. TPB suggests that an individual's intention to perform a behavior is influenced by three factors:

- Attitude Toward the Behavior - the degree to which a person has a favorable or unfavorable evaluation of the behavior.
- Subjective Norms - the perceived social pressure to perform or not perform the behavior.
- Perceived Behavioral Control - the extent to which a person believes they can control the performance of the behavior, which can directly influence both intention and behavior.

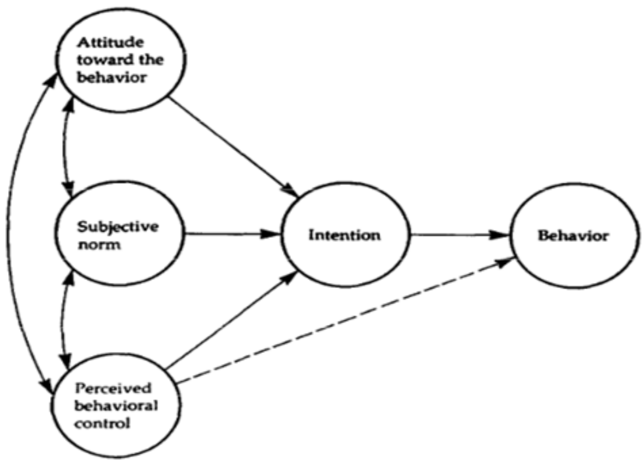

Figure 4. *The Theory of Planned Behavior (TPB) (Source: Ajzen, 1991)*

TPB has been used to predict and understand users' intentions to engage with XR technologies, considering not only attitudes and social influences but also the perceived control over using these advanced technologies.

For example, (Ajzen's, 1991) study demonstrates that TPB can effectively predict the adoption of AR applications in consumer contexts.

The Theory of Planned Behavior (TPB) has been increasingly utilized to evaluate the acceptance and adoption of XR technologies, particularly in educational and consumer contexts.

For example, a recent study by (Cheng & Tsai, 2020) investigated the factors influencing students' intentions to use Augmented Reality (AR) applications for learning. The study found that perceived behavioral control, alongside attitudes toward AR and subjective norms, significantly predicted students' behavioral intentions to use AR in educational settings. Another study by (Hamari et al., 2021) applied TPB to explore the adoption of Virtual Reality (VR) in the gaming industry. This research highlighted that perceived behavioral control and subjective norms were strong predictors of gamers' intentions to continue using VR technologies.

Task-Technology Fit Model (TTF)

The TTF (task-technology fit, TTF) model was proposed by Goodhue and Thompson (1995) to understand the link between information systems and individual performance (Figure 5).

The Task-Technology Fit (TTF) model focuses on assessing the alignment or fit between the characteristics of tasks performed by users and the technological capabilities provided by XR systems. TTF emphasizes that optimal performance and user satisfaction are achieved when there is a good fit between task requirements and technology features. The main components of the model are:

- Task Characteristics -attributes of tasks such as complexity, frequency, and criticality.
- Technology Characteristics - features of XR systems such as interactivity, realism, and responsiveness.

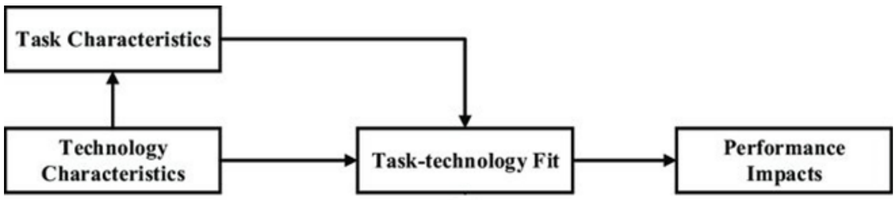

Figure 5. *The Task Technology Fit Model (Goodhue & Thompson, 1995)*

In this model, task characteristics refer to the actions taken by individuals, while technology characteristics refer to the technology used to perform the tasks. The TTF model refers to the extent to which a technology assists the individual in performing their tasks. Performance impact refers to the accomplishment of a set of tasks by an individual. For instance, (Goodhue & Thompson, 1995) developed the TTF model to explore how the compatibility between task demands and technology features influences individual performance and acceptance of technology.

By evaluating the fit between these factors, researchers can predict how well XR technologies support users in accomplishing tasks effectively and efficiently. Studies applying TTF have examined its role in enhancing user performance and satisfaction in various XR applications, from training simulations to collaborative work environments (Jung et al., 2024; Ratmono et al., 2024).

Flow Theory

Flow Theory, proposed by (Csikszentmihalyi, 1990), describes the optimal psychological state that individuals experience when fully immersed in an activity. In the context of XR technologies, flow theory examines how users perceive their engagement and satisfaction while interacting within virtual or augmented environments.

Key Constructs of Flow: Balance between challenge and skills, clear goals, immediate feedback, concentration, loss of self-awareness, and sense of control.Flow Theory suggests that XR experiences are most engaging when users experience a balance between the difficulty of tasks presented by the XR system and their own skills and capabilities. Achieving a state of flow enhances user enjoyment, performance, and overall satisfaction with the XR experience.

Researchers apply Flow Theory to evaluate user engagement and immersion in XR applications, identifying design principles that promote optimal user experiences and sustained interaction.For example, studies have applied Flow Theory to assess the usability and user experience of VR games and simulations, highlighting the importance of maintaining an appropriate challenge level to sustain user engagement (Hamari et al., 2016).

APPLYING THEORIES AND MODELS OF ACCEPTANCE OF XR TECHNOLOGIES

In the case of XR technologies, theories and models of technology acceptance are used to determine the degree of acceptance/adoption, to analyze user behavior, to determine user satisfaction with use, and to identify factors that determine adoption /acceptance, etc. Assuming such XR technologies are accepted, their success will depend on their continued adoption and use by individuals. Therefore, understanding the factors that motivate users to continue using IoT devices is of particular importance.

A synthesis of the most widely used acceptance models and theories used in investigating the adoption of different types of XR technologies is presented in Table 1:

Table 1. *Synthesis of acceptance models and theories used in the evaluation of XR technologies*

Research	Technology	Models/Theories of acceptance			
		TAM	TRA	TPB	TTF
Rauschnabel și Ro (2016)	Augmented reality		X		
Ratmono et al. (2024)	Virtual Reality				X
Jung et al. (2024)	Extended Reality				X
Venkatesh and Bala (2008)	General IT systems	X			
Huang et al. (2016)	Virtual Reality	X			
Verhagen et. al (2014)	Virtual Mirrors		X		
Cheng and Tsai (2020)	Augmented Reality			X	
Hamari et al. (2021)	Virtual Reality			X	
Teo (2011)	Educational technology	X			
Montano & Kasprzyk (2015)	General IT systems		X	X	

The study of (Rauschnabel & Ro, 2016) explores the factors influencing the acceptance of Augmented Reality (AR) smart glasses. By applying the Theory of Reasoned Action (TRA), the research highlights the importance of subjective norms in user adoption. It also provides insights into how social influence and individual attitudes can drive the acceptance of emerging AR technologies in various contexts.

Focused on Extended Reality (XR) technologies, the study of (Jung et al., 2024) uses the Task-Technology Fit (TTF) model to assess how XR applications meet user needs across various environments. The research suggests that when

XR technologies are well-aligned with user tasks, they significantly improve engagement and overall experience. This study is crucial for understanding how different XR applications can be tailored to enhance user interactions in diverse settings.

The research of (Ratmono et al., 2024) investigates the effectiveness of Virtual Reality (VR) in educational contexts, particularly in accounting studies. The study employs the Task-Technology Fit (TTF) model to examine how well VR technology aligns with educational tasks, finding that a strong fit enhances learning outcomes. The findings underscore the importance of matching technological capabilities with the specific requirements of the tasks to optimize user performance and satisfaction.

(Venkatesh & Bala, 2008) applies the Technology Acceptance Model (TAM) to general IT systems, offering insights into how perceived usefulness and ease of use influence technology adoption. Although not exclusively focused on XR, the findings provide a foundational understanding of user acceptance that can be applied to XR technologies, highlighting the importance of intuitive and beneficial technology design in driving adoption.

(Huang et al., 2016) examines the acceptance of VR in medical education using the Technology Acceptance Model (TAM). The study reveals that perceived ease of use and perceived usefulness are critical factors in the adoption of VR technologies in educational settings. The results emphasize the need for user-friendly and practical VR applications to facilitate their integration into educational curricula.

Regarding the use of Augmented Reality (AR) in educational contexts, (Cheng & Tsai, 2020) applies the Theory of Planned Behavior (TPB) to understand students' intentions to use AR for learning. The research identifies perceived behavioral control, attitudes, and subjective norms as key predictors of AR adoption, offering valuable guidance for developing AR tools that are more likely to be embraced by students.

(Hamari et al., 2021) explores the adoption of VR in the gaming industry using the Theory of Planned Behavior (TPB). The study finds that perceived behavioral control and subjective norms are strong predictors of gamers' intentions to continue using VR technologies. The insights provided are essential for designing VR games that meet user expectations and encourage long-term engagement.

Applying the Technology Acceptance Model (TAM) to educational technology, (Teo, 2011) highlights the importance of perceived ease of use and usefulness in driving the adoption of new educational tools. Although not specifically focused on XR, the findings are relevant for understanding how similar factors can influence the adoption of XR technologies in educational settings.

(Montano & Kasprzyk, 2015) integrates the Theory of Planned Behavior (TPB) with general IT systems, examining how attitudes, subjective norms, and perceived behavioral control influence technology adoption. The research offers a broader perspective on the psychological and social factors that can impact the acceptance of XR technologies, particularly in complex or sensitive application areas like healthcare.

Overall, the table provides a comprehensive overview of the application of various acceptance models and theories in the evaluation of XR technologies across different studies. It highlights the predominant use of models like the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB), indicating their widespread relevance in understanding user acceptance and adoption of XR systems. The inclusion of studies applying the Task-Technology Fit (TTF) model underscores the importance of aligning technological capabilities with user tasks to optimize performance and satisfaction. The table also reflects the versatility of these theoretical frameworks, demonstrating their applicability across diverse XR contexts, from education and healthcare to gaming and online shopping. Overall, the synthesis emphasizes the critical role of both individual psychological factors and task-specific technological alignment in driving the successful adoption and sustained use of XR technologies.

CONCLUSIONS

The evaluation of XR technologies is a multifaceted and evolving field that requires the integration of practical evaluation methods and theoretical models to comprehensively understand and predict user interactions with these immersive environments. Usability, user experience, and performance evaluation methods provide critical insights into the practical aspects of XR systems, while theoretical models like TAM, TRA, TPB, TTF, and Flow Theory offer deeper explanations of user acceptance and engagement.

These models help to elucidate the underlying psychological processes that influence user decisions to adopt and utilize XR technologies, ranging from the perceived usefulness and ease of use, as described by TAM, to the role of social influences and perceived behavioral control, as articulated by TRA and TPB. The inclusion of TTF emphasizes the importance of aligning the capabilities of XR technologies with the specific tasks, users aim to accomplish, while Flow Theory underscores the significance of creating immersive experiences that captivate users and foster deep engagement.

As XR technologies continue to advance, the need for rigorous and adaptive evaluation approaches becomes increasingly important. Future research should focus on developing innovative evaluation techniques that can keep pace with the rapid evolution of XR technologies and their expanding applications. Additionally, the continued refinement and validation of theoretical models in the context of XR will contribute to a more nuanced understanding of how these technologies are perceived, adopted, and used across different domains.

However, despite the progress made in this field, several challenges remain. The rapid pace of technological advancement in XR poses difficulties for researchers and developers to keep evaluation methods up-to-date. Moreover, the diversity of XR applications and user groups calls for tailored evaluation approaches that can address specific contexts and user needs. Addressing these challenges requires ongoing collaboration between researchers, practitioners, and end-users to develop and validate new evaluation frameworks that are both flexible and comprehensive.

As XR technologies continue to evolve and diversify, the demand for evaluation frameworks that can be tailored to various application contexts and user demographics is becoming increasingly urgent. Future research should prioritize the development of flexible and scalable evaluation tools that can be customized to meet the specific requirements of different XR applications — whether in education, healthcare, entertainment, or industry. These adaptive frameworks will enable more precise assessments of user experience and technology effectiveness across a wide range of scenarios. Several key areas of future research and development include:

- Adaptive Evaluation Frameworks - as XR technologies continue to diversify, there is a pressing need for evaluation frameworks that can adapt to different application contexts and user demographics. Future research should focus on creating modular and scalable evaluation tools that can be customized to fit the specific needs of various XR applications, whether in education, healthcare, gaming, or industrial settings.
- Integration of AI and Machine Learning - the incorporation of artificial intelligence (AI) and machine learning into XR evaluation processes holds great promise. These technologies can be used to analyze large datasets of user interactions, providing deeper insights into user behavior, preferences, and pain points. AI-driven evaluation tools could offer real-time feedback to developers, enabling more responsive and user-centered design iterations.
- Longitudinal Studies on User Adoption - while many existing studies on XR focus on initial user acceptance, there is a need for more longitudinal research that examines how user engagement

with XR technologies evolves over time. Such studies would provide valuable insights into the factors that contribute to sustained use, abandonment, or the transition to newer technologies.

- Cross-Cultural and Accessibility Research - as XR technologies become more globally adopted, understanding how cultural differences and accessibility needs influence user acceptance and experience is crucial. Future research should explore the impact of cultural factors on XR adoption and develop evaluation methods that are inclusive of users with diverse abilities and backgrounds.
- Ethical Considerations and User Privacy - with the increasing use of XR technologies, particularly in sensitive areas such as healthcare and education, ethical considerations around user privacy and data security are becoming more prominent. Future evaluation frameworks should incorporate ethical guidelines that ensure user data is handled responsibly and that XR systems are designed to protect user privacy.
- Evaluation of Hybrid XR Systems - the emergence of hybrid XR systems, which combine elements of augmented, virtual, and mixed reality, presents new challenges for evaluation. Research should focus on developing methods to assess the unique user experiences and technical challenges posed by these hybrid environments, ensuring that they meet the high standards expected by users.

Ultimately, the successful integration and adoption of XR technologies depend on a holistic approach to evaluation that combines practical insights with theoretical understanding, ensuring that these technologies meet user needs and achieve their intended impact.

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