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MANAGEMENT | RESEARCH ARTICLE

The impact of XR applications' user experience-based design innovativeness on loyalty

Joo-Eon Jeon^{1*}

Abstract: Web-based extended reality (XR) is an umbrella term for applications such as augmented reality and virtual reality. However, prior studies have only focused on the technological advancement of XR applications. Thus, this research explored the impact of the user experience-based design innovativeness (UXBDI) of XR applications, which refers to the novelties in the design of an existing application created to satisfy user loyalty. This research proposed and examined how XR applications' UXBDI affect user engagement and loyalty and used structural equation modeling to test the impact of UXBDI on web-based XR application loyalty. A total of 332 users of XR applications participated in the online questionnaire. The findings revealed that attractiveness and interaction, as sub-dimensions of UXBDI, increased XR application engagement. Moreover, an indirect effect of usability on loyalty indicated that engagement acts as a mediator. This study demonstrates that XR applications' UXBDI is a key component for the user-XR application relationship. These results are meaningful in guiding the management of the XR application cycle.

Subjects: Management of IT; Technical Communication; Business, Management and Accounting

Keywords: XR application; user experience; design innovativeness; engagement; loyalty

1. Introduction

Since the onset of the coronavirus disease 2019 (COVID-19) pandemic in early 2020, many people have had to shift their daily activities, such as shopping and cultural events, online. Consequently, a new technology for overcoming space-time limitations has led to the proliferation of immersive technology using wired communications. Especially because of the pandemic, extended reality



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PUBLIC INTEREST STATEMENT

This study provides an understanding of user experience of extended reality (XR) applications. This study also empirically investigates the impacts of user experience-based design innovativeness (UXBDI) on loyalty toward XR applications. In addition, this research examines the mediating role of engagement between UXBDI and loyalty toward XR applications. This study shows that XR applications' UXBDI is a key component for the user-XR application relationship and provides managerial implications for XR managers.

(XR) technologies, including augmented reality (AR) and virtual reality (VR), are playing increasingly important roles in socioeconomic development (Xi et al., 2022). Subsequently, this technology is changing how companies create and sustain customer value.

According to this trend, “metaverses,” virtual worlds (VW) featuring collapsed reality and virtual spaces, along with immersive technology such as AR and VR, have gained attention (Choi & Kim, 2017; Dionisio et al., 2013; Hendaoui et al., 2008). Metaverse platforms include a 3D space, in contrast to the more inclusive “cyberspace” (Dionisio et al., 2013). Nevelsteen (2018) defined metaverses as mixed spaces in which real and virtual elements merge in a continuum. Metaverse platforms develop as technology allows for the greater possibility of ubiquitous gadgets, and these platforms are spreading their influence in various ways (S. G. Lee et al., 2011). The constructs in metaverses are situated in XR that creates the opportunity to leverage new platforms of usability, design, and interaction in the VW. XR offers a collective construct that covers both VR and AR technologies, which are used interchangeably with mixed reality (Fast-Berglund et al., 2018; Kim & Hall, 2019; Kwok & Koh, 2021). XR is related to a real-virtual continuum that facilitates the introduction of virtual elements in real spaces through AR or placing real behaviors in virtual spaces through augmented virtuality (Glebova, 2020). Thus, these XR technologies are defined as immersive technologies where people behave as if the technological space is a real space.

The emergence of XR applications is expected to shape the evolution of many current immersive-related technological suites (Papagiannidis & Bourlakis, 2010). Resnick (2005) suggests that sociotechnical capital is upgraded with immersive technology development. Further, community networks have become stronger than ever, and people continuously leave traces of their behaviors in the VW. Immersive technology, including XR, has increased the rate of related technology adoption, with users starting to connect through smart devices (Agarwal & Lucas, 2005). XR technology provides the information and communication technologies that affect user experience (UX) in virtual space (Xing et al., 2022).

Understanding UX holistically requires the examination of design innovation in the usage context of XR applications. However, prior studies have focused only on the technological advancement of XR, while studies on web-based XR’s UX and loyalty are rare (Choi & Kim, 2017; S. G. Lee et al., 2011; MacCallum & Parsons, 2019; Rehm et al., 2015; Wright et al., 2008). Moreover, attempts to examine design innovation from the perspective of UX in XR applications have been lacking. UX-based design innovativeness (UXBDI) is generally understood as a multidimensional construct and is defined as the design novelties of an existing application that is created to satisfy experience (Desmet & Hekkert, 2007; Hassenzahl & Tractinsky, 2006; Jeon, 2021; Jeon & Kim, 2021; Law et al., 2009). To obtain a positive UX in the application environment, an application should be user-friendly with criteria such as sensory pleasure, novelty, or attractiveness (Jeon, 2021; Shin, 2016). This study predicts that the XR applications will further advance in four key features of UX: novelty, attractiveness, usability, and interaction.

There are few generalized theories about these applications because XR-related research is still in the nascent phase. Specifically, studies on the design and strategies that can enhance UX within XR applications have been lacking. Thus, this research suggests applying the XR application’s UXBDI to experience loyalty.

The principal objective of this study is to model the relationship between the XR application’s UXBDI and loyalty. This research demonstrates that XR applications’ UXBDI can increase users’ engagement and loyalty, thereby revealing the impact of XR applications’ UXBDI on application loyalty. For the model testing, I also investigate the development of measurement scales of the UXBDI dimension and use structural equation modeling (SEM) to examine this hypothesis. As an exemplary experience, I select a web-based XR application that provides customer touchpoints with XR in daily interactions. Thus, I collect data from XR applications and analyze the path using the XR UXBDI’s engagement and loyalty as the variables. Based on the literature review on UX and

immersive technologies, I propose using SEM—combining dimensions of UX, engagement, and loyalty—for this research. Measuring the UXBDI of the XR application represents a new research focus that can provide new findings for decision-makers in immersive technology industries.

2. Literature review and hypotheses development

2.1. XR and metaverses

A metaverse has been conceived in the literature as a globally accessible and collectively used virtual space and an immersive technology created by the convergence of virtual environment and physical reality (MacCallum & Parsons, 2019; Stephenson, 1992). In recent years, the construct has grown beyond a VW, including aspects of networks, physical worlds, and interfaces that interact with virtual spaces (Dionisio et al., 2013; Hendaoui et al., 2008; Papagiannidis et al., 2008). Since Stephenson's (1992) novel was published, ubiquitous computing gadgets have enabled the VW to exist, and more expansive and complex conceptions of metaverse platforms have developed accordingly.

The metaverse roadmap suggested classifying the metaverse into AR, VWs, mirror worlds, and lifelogging. This concept refers to both AR and VR. Various extrapolations have been made based on technological, social, and other aspects. Factors that predict the success of XR application development have also been indicated (MacCallum & Parsons, 2019).

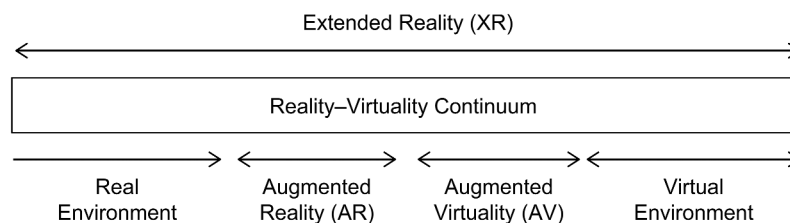
Mozumder et al. (2022) suggest that the metaverse consists of two types, according to technology: augmentation and simulation. First, augmentation is defined as a technology that adds new capabilities to the existing physical space, and these technologies add a layer of information on top of the physical system for user control. Next, simulation is defined as a technology that models realities in a virtual space, and these technologies simulate the physical space as a locus for interaction (Mozumder et al., 2022).

Combining the two typologies results in two types of XR applications: AR and VR. This classification emphasizes different functions and sets. First, AR is based on the advent of networks and virtual maps (Wright et al., 2008). That is, AR enhances the physical world using location-awareness systems that process information in the real environment (Adner & Kapoor, 2010; Dionisio et al., 2013). AR is present in web-based applications such as Instagram and allows users to interact with virtual components in the display modes we have in real-time through smart devices (De la Fuente Prieto et al., 2022). AR is adopted in XR applications to transform objects in real space digitally. It is a component of digitalized identity and provides endless opportunities for the development of fictional characters and personalities.

Second, VR is the most common XR platform. VR increasingly augments the social life of physical environments (Hendaoui et al., 2008; Papagiannidis et al., 2008). Role-playing games like Roblox or Fortnite allow users to interact in imagined 3D spaces (De la Fuente Prieto et al., 2022). The main component of the VR is the user's avatar. As in the physical environment, the social functioning of the user's VR avatar grows faster, and the learning experience can be significantly accelerated. VR can allow avatars to interact in 3D (Papagiannidis et al., 2017).

AR and VR have been considered core concepts in XR technologies. Milgram and Kishino (1994) introduced reality–virtuality continuum environments, where the real and virtual environments are placed in opposite locations with AR located between them. XR applications stand for collaboration between VR and AR. XR applications allow users to experience an imagined interaction space (Glebova, 2020; Lee & Yoo, 2021). Prior research describing XR constructs has been considered as adopting a declarative approach because of human literacy and intelligibility that enables easy modification and control of content (Lee & Yoo, 2021). To solve this issue, this study proposes a web-based XR application, as the web has application-independent attributions (Figure 1).

Figure 1. The XR application concept's expansion based on Milgram and Kishino.



2.2. UX

UX is the combination of interactions between a user and an application within the context of its use (Hassenzahl & Tractinsky, 2006; Law et al., 2009). The term “UX” is associated with various meanings, from traditional usability to the emotional or experiential aspects of use (Forlizzi & Battarbee, 2004). In other words, UX is about people’s emotions and behaviors while interacting with applications (Hussain et al., 2018). ISO 9241–210 defines UX (Law et al., 2009) as an individual’s responses and perceptions considering the use of an application or product. Thus, it is considered a broad construct that includes any cognitive, emotional, or physical response to a specific or supposed use of an application before, during, and after use. From a practical perspective, UX describes broader approaches than utility by including sensory and hedonic experiences (Forlizzi & Battarbee, 2004). This study proposes an examination of UX using social applications where people interact through user interfaces, which include knowledge systems and entertainment (Law et al., 2009).

As a result, UX can be defined simply as attitudes, perceptions, emotions, and behaviors across the usage occasion (Beauregard & Corriveau, 2007; Hinderks et al., 2019). That is, this construct suggests the psychological nature of UX by highlighting that many categories of UX are cognitive elements (Hussain et al., 2018). UX is about constructs that meet more than just instrumental needs but recognizes their use as being subjective, situational, and complex. Therefore, UX is a consequence of a user’s internal state and the attributions of the designed system.

Jordan (2000) suggested a model based on the premise that products involve people for the three levels of UX—functionality, usability, and experience. Functionality is the lowest level and refers to what a product can do; in other words, it indicates that the product reliably does what it claims to do. Next, usability refers to how users interact with products to complete or control their behaviors in a usage context; users should find it easy to accomplish intended objectives by interacting with products. Finally, experience is at the highest level.

For a new product development perspective, Shin et al. (2017) proposed a UX design. They separated the UX dimensions of the experiential network into distribution and connection dimensions. The first type of experiential network is the ecosystem experience. In this network, all platforms are connected and can share information, with all design platforms being compatible. Within this network, it is possible to use the correct experiential object to enable the direct and efficient use of various functions. The second type is an integration experience. In this type, several experiential components are combined by a core feature and connected to one another. In this network, the core artifact is a key hub. Users can manage various tasks and functions through their experiences and core artifacts. The third type is a combination of experiences. In this network, the core artifact plays a key role, like a gateway in a computer network. Users can experience various tasks through this converged artifact. The last type is the individualization experience. This type emphasizes the relationship between a single user and a single core artifact without an entire network. Therefore, a core artifact can be viewed as a product specialized in one concept. These networks are easy to find in everyday situations, including household appliances, office supplies, and other devices. Recent research has highlighted that usability, value, and affect are the key constructs of UX (H. J. Lee et al., 2018)

2.3. UXBDI

The term “design” generally refers to decisions about various aspects of a component’s structure and the various frameworks within which a product is created (Bloch, 1995; Candi, 2010; Dion et al., 1972; Hevner et al., 2004). Product design is defined specifically as the choices of attributes related to component, color, and proportion, also known as industrial design or aesthetic design (Bloch, 1995; Rampino, 2011).

The technological design suggests new functional properties. Conversely, product design creates aesthetic and symbolic qualities by supplying attributes that include socio-cultural meanings (Muggee & Dahl, 2013; Norman, 2003; Walsh et al., 1992). Product design and technological developments interact to define how users understand the functionality and how they emotionally respond to them. Strategically, product design can be chosen to affect user responses to innovation (Muggee & Dahl, 2013; Mutlu & Er, 2003; Wrigley & Bucolo, 2011).

Combining product form design and technological innovation is important because they determine together the newness that product innovation presents to users (Muggee & Dahl, 2013; Veryzer, 1998; Wrigley & Bucolo, 2011). The novelty of innovation influences the cognitive and emotional responses that determine user evaluation of the benefits of a new product.

This study intends to plug existing research gaps by providing otherwise lacking definitions. It utilizes the concept of design as defined by Aubert (1982), Freeman (1982), and Walsh et al. (1992): creative, new, and not present before. To this is added the innovation concept defined by Schumpeter (1934): new and improved. Prior research on product design offers definitions derived from the concept of innovation. However, it is difficult to define design innovation because it varies depending on the context, and few studies, including those on design and innovation, have offered a generally agreed-upon definition. On the surface, design innovation appears to have two types (Mutlu & Er, 2003, p. 13). First, “innovation in design” is defined as “novelties introduced in the design of a particular artifact.” Second, “innovation by design” is defined as “a new novelty in an artifact acquired by the design function.”

In addition, the connection between design and innovation is meant to provide UX. Successful innovation depends on understanding the UX and satisfying various experiences by developing products or services (Dewar & Dutton, 1986). Thus, this study links marketing and innovation to define design innovation. UX is key in connecting design and innovation; a superior marketing purpose is required to satisfy user (customer) experiences.

By combining UX and design innovation, Jeon and Kim (2021) conceptualized UXBDI as a novelty in designing an existing application related to satisfying UX. Their research demonstrated that UXBDI consists of four dimensions: novelty, attractiveness, usability, and interaction.

The first dimension, novelty, is the newness of a design (Mugge & Schoormans, 2012). Combining technological innovation and aesthetic design is important because the application determines the novelty that an innovation presents to users. Novelty can affect the cognitive and emotional responses that determine user assessments of a new application’s benefits. The second dimension, attractiveness, is an inner feeling comprising an evaluation of the application’s interface looking attractive, enjoyable, friendly, and pleasant. XR applications can provide visual elements that activate the various schemas through which the applications are interpreted. Puccinelli et al. (2009) insisted that attractiveness positively influences all stages of the decision process: need, information searching, alternative evaluation, purchase, and post-purchase. Aesthetic applications can attract users and provide sensory experiences. The third dimension, usability, is the functional performance of an application. Defining applications’ usability and maintainability requires dealing with their quality of use. Usability indicates that the quality of use meets with user-product interaction in a usage context. It is the relationship between a specific user and XR, way of use, safety, and reliability. Prior studies have suggested explanations for the relationship between

usability and engagement. Nambisan's and Nambisan's (2008) research on VWs also noted that, regardless of the technological complexity, the usability with which users can interact with and perform tasks shapes the virtual experience. The last dimension, interaction, refers to the interaction with an application being predictable and meeting expectations. Interaction includes any type of cognitive, emotional, or physical responses before, during, and after using a metaverse related to its specific or supposed use. Jeon (2021) found that attractiveness and interaction increased user-metaverse platform identification and commitment.

Thus, the UXBDI has resulted in XR applications characterized by practical, symbolic, and aesthetic dimensions that control how users react to the applications. XR applications are immersive technologies that allow users to interact authentically in a virtual space by letting them experience a sense of presence in these spaces (Slater, 2009).

XR engagement is defined as the level of UX with XR technology (O'Brien & Toms, 2008, p. 23; Vo et al., 2022). In virtual spaces, XR engagement is associated with individuals' experiences during exploration. Engaged users are relevant to platform performance as they decide to grant higher levels of attention and intention to interact with a platform (Lourenço et al., 2022). Therefore, prior scholars have attempted to develop a better understanding of user motives that produce durable connections with the application. From the UXBDI perspective, XR engagement reflects an application's effort to experience design innovation. XR applications may enhance users' self-motivation by enabling seemingly impossible experiences and by offering users the ability to manipulate happenings within these virtual spaces. Deeper, more durable engagement is found when users invest more effort in using XR applications.

Thus, XR engagement is the application's appraisal of various contributions corresponding to UXBDI. Independent variables relate to sub-elements of UXBDI, such as novelty, attractiveness, usability, and interaction. Considering this evidence, this study expects XR's UXBDI to influence XR engagement positively. That is, novelty, attractiveness, usability, and interaction can positively influence XR application engagement. Given these points, the following hypotheses are proposed:

H1: XR applications' novelty positively influences engagement.

H2: XR applications' attractiveness positively influences engagement.

H3: XR applications' usability positively influences engagement.

H4: XR applications' interaction positively influences engagement.

2.4. XR application loyalty

User loyalty can be viewed as an ongoing intention to maintain a relationship (Jeon, 2021). Loyalty is one individual's intention to ensure that the continuing affiliation with another entity is significant and profitable. Thus, it is worth making an effort to guarantee the persistence of this relationship. Loyalty to an application is related to various psychosocial responses, such as social capital and wellbeing. An application's loyalty encompasses several factors (McCay-Peet & Quan-Haase, 2016). The first factor is a user's self-presentation, and the second factor is providing positive experiences that help maintain user commitment. The last factor is usage and activity counts, which can represent either overall usage or data presented to the user about their behavior. This definition of loyalty was developed for the XR application in general (Sigerson & Cheng, 2018).

In the application context, XR application loyalty is defined as the user's confidence to maintain the relationship from a long-term perspective and retain a willingness to remain with the

relationship (Goutam & Gopalakrishna, 2018). Loyalty can be defined as a user-immersive experience absorbed and engrossed in the XR application (Vo et al., 2022). Thus, XR application loyalty is conceptualized as the quality of UX with an application that is characterized by aesthetic and sensory appeal, usability, novelty, interactivity, and engagement (Sigerson & Cheng, 2018).

A web-based XR application, as a virtual community, enables users to share various experiences within applications. Recently, Tom Dieck and Han (2022) suggested that UXs in XR platform led to sustained loyalty for business-related purposes. The interaction between UX and XR must be consistent throughout different touchpoints to increase loyalty-enhancing responses. For an active social network user, commitment is the foundation of lasting, valuable relationships created by the UX (Kang & Schuett, 2013). Thus, users who experience an innovatively designed XR application will commit to a user-XR application relationship. Given these points, the following hypotheses are proposed:

H5: XR applications' novelty positively influences loyalty.

H6: XR applications' attractiveness positively influences loyalty.

H7: XR applications' usability positively influences loyalty.

H8: XR applications' interaction positively influences loyalty.

Loyalty, as the result of a long-term relationship between two parties, would lead one to expect that no other trade accomplice would grant advantages similar to those of its present exchange party (Goutam & Gopalakrishna, 2018). Higher engagement has been associated with several positive subjective experiences. For instance, motivation represents individuals' willingness to maintain applications. Based on these findings, the following hypothesis is proposed:

H9: XR application's engagement positively influences loyalty.

3. Materials and methods

3.1. Measurement development

This research aimed to construct a path model that would logically combine UXBDI, engagement, and loyalty. To test the research hypotheses, the author used the survey method because it is an effective way of collecting data for UX of XR applications in immersive technology. The survey questionnaire was used to collect data from users residing in South Korea, and the dataset consisted of individual levels. The author used SEM to analyze the data and demonstrate the causal relationship between the web-based XR application's UXBDI and loyalty. The measurement items are described below.

UXBDI was defined by the novelties in existing product or service design that were created to satisfy UX. This study adapted UXBDI items from Jeon's (2021) that classified UXBDI into four categories (i.e., novelty, attractiveness, usability, and interaction). Novelty was defined as the innovativeness and creativity of an XR application and was measured by three items (i.e., creatively, never seen before, and novel). Attractiveness was defined as a web-based XR application appearing attractive, enjoyable, and pleasant and was measured by three items (i.e., aesthetic, attractive, and grab). Usability was defined as the pragmatic and functional performance of a web-based XR application and was measured by three items (i.e., usable, convenient, and practical). Interaction was defined as predictability and meeting expectations and was measured by three items (i.e., actual interaction, mutual interaction, and reacting in a lively way).

Engagement was defined as the quality of user immersion within the XR application. This study adapted the items developed by Huang et al. (2021) and ; i.e., I see myself as a part of this application; I am very attached to this application; and I feel I will fit into the XR application). Loyalty was defined as an individual's intention to maintain their relationship with the XR application from a long-term perspective and was measured by three items (i.e., I am proud to belong to this application; I feel a sense of belonging to this application; and I plan to use this application regularly). These measures were adapted from the studies of Chung et al. (2017) and Goutam and Gopalakrishna (2018), and all questions were rated on a seven-point Likert scale.

3.2. Data collection and analysis

This research aimed to explain the relationship between loyalty and XR application by examining the impact of UXBDI on XR engagement. Therefore, users of XR applications were selected as the sample. A survey was conducted by a research company known as a panel institute (the Marketing Research Institute), and survey participants were recruited from the research institute panels. The author had two criteria for screening respondents: age between 20 and 40 and current web-based XR application usage.

The author collected data from panelists who agreed to participate in the study for compensation. Respondents were users who had participated in a web-based XR application (Roblox, Zepeto, Animal Crossing, Instagram, Facebook, Pokémon Go, and Snow App) within the last six months. To analyze the squared equation, a statistical SEM tool with the maximum likelihood estimation procedure by default was used. More than 200 samples were required (Hair et al., 2010); consequently, the final sample comprised 332 respondents. Of these, 34.6% were men, and 65.4% were women. The participants were aged from 20 to 40, and their average age was 30.60. The author explained the purpose of the research to the participants and informed them that they could withdraw their participation at any time, all personal data would be kept confidential according to the Korean Statistical Law, and all data would be destroyed after one year.

Statistical programs IBM SPSS and AMOS were used to analyze the collected data and conduct the overall statistical analysis of the path model. First, the factors were confirmed using a confirmatory factor analysis (CFA); second, an SEM was designed and estimated to test hypotheses regarding the links among the constructs. SEM is widely used in UX to perform factor analysis and investigate the interrelationships among variables.

4. Results

4.1. Analysis of reliability and validity

The results of Cronbach's alpha should be greater than 0.7 in reliability testing; novelty should be greater than .842; attractiveness should be greater than .944; usability should be greater than .890; interaction should be greater than .882; engagement should be greater than .893; and loyalty should be greater than .844 (Bonett & Wright, 2015). Table 1 presents the values of the mean and standard deviation. The results indicate that the XR applications' UXBDI could be considered on a multidimensional scale, including novelty, attractiveness, usability, and interaction.

Table 1. Descriptive results

	Mean	SE	SD
Novelty	4.687	.065	1.194
Attractiveness	4.408	.065	1.187
Usability	4.545	.061	1.125
Interaction	4.451	.062	1.146
Engagement	3.459	.076	1.391
Loyalty	3.934	.072	1.323

Next, a researcher confirmed convergent validity and discriminant validity through CFA. Table 2 presents the results of CFA. All the model fit indicators were acceptable. Thus, model fit was also found to be significant, based on the following values: root mean square error of approximation (RMSEA) = .085; normed fit index (NFI) = .921; comparative fit index (CFI) = .942; Tucker-Lewis index (TLI) = .927; incremental fit index (IFI) = .943 with $\chi^2 = 405.468$, $p < 0.001$, and degrees of freedom = 120.

4.2. Hypothesis testing

Table 3 presents the results. All the model fit indicators were acceptable. Thus, model fit was found to be significant (RMSEA = .088; NFI = .919, CFI = .936; TLI = .918; IFI = .936 with $\chi^2 = 531.083$, $p < 0.001$). Figure 2 shows the results of the hypotheses tests. The solid lines indicate a significant relationship, whereas dotted lines indicate non-significant relationships.

The results revealed that attractiveness ($b = .184$, $p < .05$) and interaction ($b = .587$, $p < .05$) had a significant positive effect on engagement; however, novelty ($b = -.018$, $p = .752$) and usability ($b = .044$, $p = .363$) had a non-significant positive effect on engagement.

Next, the results revealed that usability ($b = .076$, $p < .05$) had a significant positive effect on loyalty, whereas novelty ($b = .060$, $p = .146$), attractiveness ($b = .016$, $p = .707$), and interaction ($b = .020$, $p = .703$) were not significant. Finally, engagement significantly affected loyalty ($b = .886$, $p < .001$). These results reveal that the direct effect of usability on loyalty is significant. That is, the usability of the XR application seems to be a stronger predictor of loyalty than the other features. In addition, these results reveal a significant indirect effect of attractiveness and interaction on loyalty, indicating that engagement acts as a partial mediator of the XR's UXBDI-loyalty relationship.

5. Discussion

5.1. Findings

This study offers some important findings. First, it confirmed that attractiveness and interaction, as sub-dimensions of UXBDI, significantly influence engagement. That is, the research results indicated that engagement reflects users' positive appraisal of the application in terms of attractiveness and usability. However, both novelty and usability did not significantly affect engagement. Second, usability was directly related to loyalty. That is, XR application loyalty is developed through practical benefits. Conversely, novelty, attractiveness, and interaction were not directly related to loyalty. In addition, the results revealed a significant, indirect effect of attractiveness and interaction on loyalty, indicating that engagement acts as a mediator in this relationship.

Specifically, this research found that novelty did not influence engagement and loyalty. Previous studies have suggested that novelty may translate to increased XR attention (Huang et al., 2021). However, this research confirmed that novelty does not affect XR engagement and loyalty. The introduction of novelty is likely to affect severe incongruity within XR applications. The more incongruous a web-based XR is, the more difficult it is and the more cognitive effort it requires for users to engage with the application.

5.2. Contribution

This study contributes by identifying that the UXBDI of XR applications is a key component for XR application relationships. The Acceleration Studies Foundation emphasizes the importance of how UXs should be designed and built so that metaverse applications can continue developing (Mozumder et al., 2022). However, research on UX design is lacking, with most studies focusing only on the immersive technology development of the XR application. This study confirmed that UXBDI attractiveness, usability, and interaction significantly increased the user-XR application relationship, which is meaningful for revealing UXBDI's important role. It suggests opportunities to improve UX between AI algorithmic explanations and actionable understanding. The UXBDI

Table 2. Confirmatory factor analysis

Scale	Estimate	Standardized Estimate	SE	CR	P	AVE
Novelty						.683
Novelty 1	1.000	.817				
Novelty 2	1.184	.705	.084	14.010	.000	
Novelty 3	1.331	.941	.071	18.810	.000	
Attractiveness						.817
Attractiveness 1	1.000	.892				
Attractiveness 2	.993	.919	.039	25.363	.000	
Attractiveness 3	1.024	.912	.041	24.992	.000	
Usability						.725
Usability 1	1.000	.858				
Usability 2	1.103	.895	.053	20.662	.000	
Usability 3	.956	.799	.055	17.489	.000	
Interaction						.725
Interaction 1	1.000	.852				
Interaction 2	1.163	.910	.048	24.455	.000	
Interaction 3	1.018	.817	.049	20.908	.000	
Engagement						.739
Engagement 1	1.000	.797				
Engagement 2	1.221	.893	.064	18.973	.000	
Engagement 3	1.176	.887	.063	18.801	.000	
Loyalty						.648
Loyalty 1	1.000	.799				
Loyalty 2	1.071	.882	.057	18.847	.000	
Loyalty 3	.881	.728	.061	14.535	.000	

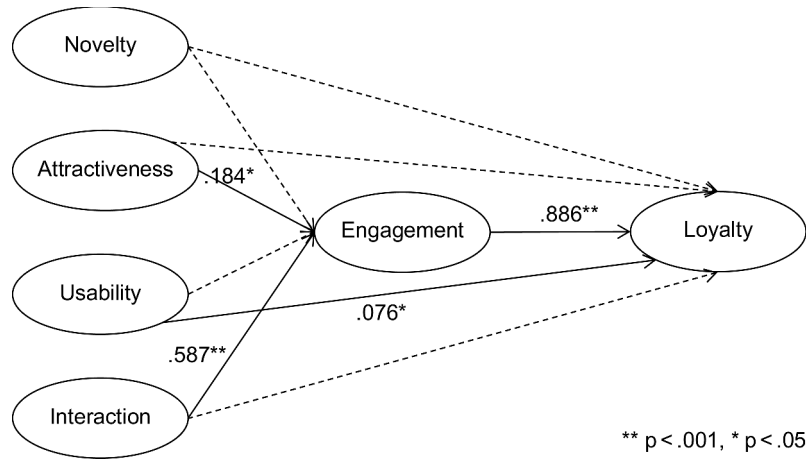
Notes: $\chi^2 = 405.468$ ($p = .000$, $df = 120$); RMSEA = .085; NFI = .921; CFI = .942; TLI = .927; IFI = .943.

Table 3. Results of structural equation modeling

	Estimate	Standardized Estimate	SE	CR	P
Novelty → Engagement	.023	.018	.074	.315	.752
Attractiveness → Engagement	.213	.184	.067	3.171	.002
Usability → Engagement	.052	.044	.057	.909	.363
Interaction → Engagement	.669	.587	.074	8.989	.000
Novelty → Loyalty	.081	.060	.055	1.453	.146
Attractiveness → Loyalty	.019	.016	.051	.377	.707
Usability → Loyalty	.094	.076	.043	2.196	.028
Interaction → Loyalty	.024	.020	.064	.382	.703
Engagement → Loyalty	.928	.886	.064	14.485	.000
Novelty → Novelty 1	1.000	.805			
Novelty → Novelty 2	1.212	.698	.078	15.525	.000
Novelty → Novelty 3	1.304	.923	.065	20.221	.000
Attractiveness → Attractiveness 1	1.000	.862			
Attractiveness → Attractiveness 2	1.081	.922	.040	26.782	.000
Attractiveness → Attractiveness 3	1.105	.901	.043	25.833	.000
Usability → Usability 1	1.000	.828			
Usability → Usability 2	1.003	.834	.048	20.703	.000
Usability → Usability 3	1.125	.928	.049	23.029	.000
Interaction → Interaction 1	1.000	.855			
Interaction → Interaction 2	1.163	.913	.047	24.811	.000
Interaction → Interaction 3	1.005	.810	.048	20.789	.000
Engagement → Engagement 1	1.000	.818			
Engagement → Engagement t 2	1.150	.881	.051	22.511	.000
Engagement → Engagement t 3	1.137	.890	.050	22.869	.000
Loyalty → Loyalty 1	1.000	.806			
Loyalty → Loyalty 2	1.026	.881	.047	21.892	.000
Loyalty → Loyalty 3	.724	.625	.052	13.939	.000

Notes: $\chi^2 = 531.083$ ($p = 0.000$, $df = 120$); RMSEA = .088; NFI = .919; CFI = .936; TLI = .918; IFI = .936.

Figure 2. Results of hypotheses testing.



solutions involve how to communicate XR algorithmic explanations effectively, such as engagement and loyalty. Based on this study, UXBDI-based AI algorithm design will increase XR engagement and loyalty.

This study has several important practical implications. First, tracking the UXBDI of XR applications can increase users' intention to create stronger relationships within the application. The XR application presents a challenge to creating loyalty, and the user application replacement cycle is relatively short in the application's life cycle. Users who expect an immersive experience on XR applications tend to remain in relationships. This study's findings can also help product managers understand that UXBDI design strategy should be emphasized to encourage user-XR application relationships.

Second, the results emphasize that long-term UXBDI management strategies can enhance the XR application relationship. Many companies prefer an aggressive strategy to enhance UX, including all types of physical, cognitive, or affective reactions in an XR application. This strategy suggests that XR applications are constructed by functional, aesthetic, and symbolic dimensions that jointly determine users' responses. Based on the current study's results, marketers can capitalize on UXBDI's dynamic effect over time by organizing, planning, and implementing marketing programs for users yet to commit to XR applications. This strategy can continuously provide new experiences.

5.3. Limitations and future research

This study has some limitations. First, it examined the UX of various XR applications to explain how a relationship might occur. The results demonstrated that attractiveness and interaction increased user-XR application relationships. According to existing research, interactions may result from interference with various experiences. It is expected that previous experiences with XR applications can lead to other relationship types; that is, this study excluded UX.

Second, this research did not consider the type of XR application. Prior research has categorized metaverse platforms into four types—VWs, AR, mirror worlds, and lifelogging—and it can be assumed that the extent of loyalty in the XR application types is influenced differently by UXBDI. This study provides important implications for the effects of engagement of AR and VR, offering prescriptive suggestions. It also offers insights for understanding how users commit to user relationships; therefore, to explain XR application UXBDI's effect on loyalty thoroughly, future studies should consider metaverse types and other potential determinants.

Third, a researcher aimed to verify whether the difference in design acumen was affected by the UXBDI application level based on the level of individual centrality of visual aesthetics. Clarifying the aesthetics centrality concept is potentially important for understanding decision-making (Bloch et al., 2003). Specifically, aesthetics centrality may determine how the UXBDI of XR applications is evaluated and used, and in the future, I would like to investigate comparative research by classifying metaverse types with a centrality of visual aesthetics.

Fourth, the study sample was small. Although the participants agreed to complete the study carefully, they might not accurately represent the sample population statistically. Future research should consider a larger sample size.

Finally, this study only analyzed loyalty regarding XR applications as a dependent variable. Future research can add variables derived from loyalty regarding XR application, such as commitment or attitude.

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References

- Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, 31(3), 306–333. <https://doi.org/10.1002/smj.821>
- Agarwal, R., & Lucas, J. R. H. (2005). The information systems identity crisis: Focusing on high-visibility and high-impact research. *MIS Quarterly*, 29(3), 381–398. <https://doi.org/10.2307/25148689>
- Aubert, J. E. (1982). *Innovation in small and medium firms*. OECD.
- Beauregard, R., & Corriveau, P. (2007). User experience quality: A conceptual framework for goal setting and measurement. In V. G. Duffy (Ed.), *Digital human modeling, international conference on digital human modeling* (pp. 325–332). Springer.
- Bloch, P. H. (1995). Seeking the ideal form: Product design and consumer response. *Journal of Marketing*, 59(3), 16–29. <https://doi.org/10.1177/002224299505900302>
- Bloch, P. H., Brunel, F. F., & Arnold, T. J. (2003). Individual differences in the centrality of visual product aesthetics: Concept and measurement. *Journal of Consumer Research*, 29(4), 551–565. <https://doi.org/10.1086/346250>
- Bonett, D. G., & Wright, T. A. (2015). Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning. *Journal of Organizational Behavior*, 36(1), 3–15. <https://doi.org/10.1002/job.1960>
- Candi, M. (2010). Benefits of aesthetic design as an element of new service development. *Journal of Product Innovation Management*, 27(2), 1047–1064. <https://doi.org/10.1111/j.1540-5885.2010.00770.x>
- Choi, H. S., & Kim, S. H. (2017). A content service deployment plan for metaverse museum exhibitions—Centering on the combination of beacons and HMDs. *International Journal of Information Management*, 37(1), 1519–1527. <https://doi.org/10.1016/j.ijinfomgt.2016.04.017>
- Chung, N., Tyan, I., & Chung, H. C. (2017). Social support and commitment within social networking site in tourism experience. *Sustainability*, 9(11), 2102. <https://doi.org/10.3390/su9112102>
- de la Fuente Prieto, J., Lacasa, P., & Martínez-Borda, R. (2022). *Approaching metaverses: Mixed reality interfaces in youth media platforms*. New Techno Humanities.
- Desmet, P. M. A., & Hekkert, P. (2007). Framework of product experience. *International Journal of Design*, 1(1), 57–66. <http://www.ijdesign.org/index.php/IJDesign/article/view/66>
- Dewar, R. D., & Dutton, J. E. (1986). The adoption of radical and incremental innovations: An empirical analysis. *Management Science*, 32(11), 1422–1433. <https://doi.org/10.1287/mnsc.32.11.1422>
- Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of Personality and Social Psychology*, 24(3), 285–290. <https://doi.org/10.1037/h0033731>
- Dionisio, J. D. N., Burns, W. G., III, & Gilbert, R. (2013). 3D virtual worlds and the Metaverse: Current status and future possibilities. *ACM Computing Surveys*, 45(3), 1–38. <https://doi.org/10.1145/2480741.2480751>
- Fast-Berglund, A., Gong, L., & Li, D. (2018). Testing and validating Extended Reality (xR) technologies in manufacturing. *Procedia Manufacturing*, 25, 31–38. <https://doi.org/10.1016/j.promfg.2018.06.054>
- Forlizzi, J., & Battarbee, K. (2004). Understanding experience in interactive systems. *Proceedings of the 5th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*, 261–268.
- Freeman, C. (1982). *The economics of industrial innovation*. Frances Pinter.
- Glebova, E. (2020). Définir la réalité étendue dans les sports: Limitations, facteurs et opportunités (Defining Extended Reality in Sports: Limitations, Drivers, and Opportunities). In M. Desbordes & C. Hautbois Eds.,

- Management du sports* (Vol. 3 Sports management 3.0, 271–293). *Economica*.
- Goutam, D., & Gopalakrishna, B. (2018). Customer loyalty development in online shopping: An integration of e-service quality model and commitment-trust theory. *Management Science Letters*, 8(11), 1149–1158. <https://doi.org/10.5267/j.msl.2018.8.009>
- Hair, J. F., Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis*. Pearson Education, Inc.
- Hassenzahl, M., & Tractinsky, N. (2006). User experience - A research agenda. *Behaviour & Information Technology*, 25(2), 91–97. <https://doi.org/10.1080/01449290500330331>
- Hendaoui, A., Limayem, M., & Thompson, C. W. (2008). 3D social virtual worlds: Research issues and challenges. *IEEE Internet Computing*, 12(1), 88–92. <https://doi.org/10.1109/MIC.2008.1>
- Hevner, A. R., March, S. T., Park, J., & Sudha, R. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105. <https://doi.org/10.2307/25148625>
- Hinderks, A., Schrepp, M., Mayo, F. J. D., Escalona, M. J., & Thomaschewski, J. (2019). Developing a UX KPI based on the user experience questionnaire. *Computer Standards & Interfaces*, 65, 38–44. <https://doi.org/10.1016/j.csi.2019.01.007>
- Huang, W., Roscoe, R. D., Johnson-Glenberg, M. C., & Craig, S. D. (2021). Motivation, engagement, and performance across multiple virtual reality sessions and levels of immersion. *Journal of Computer Assisted Learning*, 37(3), 745–758. <https://doi.org/10.1111/jcal.12520>
- Hussain, J., Khan, W. A., Hur, T., Bilal, H. S. M., Bang, J., Hassan, A. U., Afzal, M., & Lee, S. (2018). A multimodal deep log-based user experience (UX) platform for UX evaluation. *Sensors*, 18(5), 1622. <https://doi.org/10.3390/s18051622>
- Jeon, J. E. (2021). The effects of user experience-based design innovativeness on user-metaverse platform channel relationships in South Korea. *Journal of Distribution Science*, 19(11), 81–90. <https://doi.org/10.15722/jds.19.11.202111.81>
- Jeon, J. E., & Kim, M. R. (2021). The scale development for conceptualizing of user experience based design innovativeness. *Journal of Korea Service Management Society*, 22(2), 55–85. <https://doi.org/10.15722/jds.19.11.202111.81>
- Jordan, P. W. (2000). *Designing pleasurable products: An introduction to the new human factors*. CRC Press.
- Kang, M., & Schuett, M. A. (2013). Determinants of sharing travel experiences in social media. *Journal of Travel and Tourism Marketing*, 30(1–2), 93–107. <https://doi.org/10.1080/10548408.2013.751237>
- Kim, M. J., & Hall, C. M. (2019). A hedonic motivation model in virtual reality tourism: Comparing visitors and non-visitors. *International Journal of Information Management*, 46, 236–249. <https://doi.org/10.1016/j.ijinfomgt.2018.11.016>
- Kwok, A. O., & Koh, S. G. (2021). COVID-19 and extended reality (XR). *Current Issues in Tourism*, 24(14), 1935–1940. <https://doi.org/10.1080/13683500.2020.1798896>
- Law, E. L. C., Roto, V., Hassenzahl, M., Vermeeren, A. P., & Kort, J. (2009). Understanding, scoping and defining user experience: A survey approach. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 719–728.
- Lee, H. J., Lee, K. H., & Choi, J. (2018). A structural model for unity of experience: Connecting user experience, customer experience, and brand experience. *Journal of Usability Studies*, 14(1), 8–34. <https://uxpajournal.org/ux-cx-brand/>
- Lee, S. G., Trimi, S., Byun, W. K., & Kang, M. (2011). Innovation and imitation effects in Metaverse platform adoption. *Service Business*, 5(2), 155–172. <https://doi.org/10.1007/s11628-011-0108-8>
- Lee, Y., & Yoo, B. (2021). XR collaboration beyond virtual reality: Work in the real world. *Journal of Computational Design and Engineering*, 8(2), 756–772. <https://doi.org/10.1093/jcde/qwab012>
- Lourenço, C. E., Hair, J. F., Jr, Zambaldi, F., & Ponchio, M. C. (2022). Consumer brand engagement concept and measurement: Toward a refined approach. *Journal of Retailing and Consumer Services*, 68, 103053. <https://doi.org/10.1016/j.jretconser.2022.103053>
- MacCallum, K., & Parsons, D. (2019). *Teacher perspectives on mobile augmented reality: the potential of metaverse for learning: Proceedings of World Conference on Mobile and Contextual Learning*, Delft, Netherlands. 21–28. Metaverse Roadmap Overview.
- McCay-Peet, L., & Quan-Haase, A. A. (2016). *Model of social media commitment: User profiles, gratifications, and experiences*. Springer.
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, 77(12), 1321–1329. <https://doi.org/10.1110/2.4646>
- Mozumder, M. A. I., Sheeraz, M. M., Athar, A., Aich, S., & Kim, H. C. (2022, February). Overview: Technology roadmap of the future trend of metaverse based on IoT, blockchain, AI technique, and medical domain metaverse activity. *2022 24th International Conference on Advanced Communication Technology (ICACT)* (pp. 256–261). IEEE.
- Mugge, R., & Dahl, D. W. (2013). Seeking the ideal level of design newness: Consumer response to radical and incremental product design. *Journal of Product Innovation Management*, 30(5), 34–47. <https://doi.org/10.1111/jpim.12062>
- Mugge, R., & Schoormans, J. P. (2012). Product design and apparent usability. The influence of novelty in product appearance. *Applied Ergonomics*, 43(6), 1081–1088. <https://doi.org/10.1016/j.apergo.2012.03.009>
- Mutlu, B., & Er, A. (2003). Design innovation: Historical and theoretical perspectives on product innovation by design. *A Proceeding of 5th European Academy of Design Conference*, 1–22.
- Nambisan, S., & Nambisan, P. (2008). How to profit from a better virtual customer environment. *MIT Sloan Management Review*, 49(3), 53. <http://www.ijdesign.org/index.php/IJDesign/article/view/645/325>
- Nevelsteen, K. J. (2018). Virtual world, defined from a technological perspective and applied to video games, mixed reality, and the Metaverse. *Computer Animation and Virtual Worlds*, 29(1), 1752. <https://doi.org/10.1002/cav.1752>
- Norman, D. A. (2003). *Emotional design: Why we love (or hate) everyday things*. Basic Books.
- O'Brien, H. L., & Toms, E. G. (2008). What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the American Society for Information Science and Technology*, 59(6), 938–955. <https://doi.org/10.1002/asi.20801>
- Papagiannidis, S., & Bourlakis, M. A. (2010). Staging the new retail drama: At a metaverse near you! *Journal For Virtual Worlds Research*, 2(5), 425–446. <https://doi.org/10.4101/jvwr.v2i5.808>
- Papagiannidis, S., Bourlakis, M., Alamanos, E., & Dennis, C. (2017). Preferences of smart shopping channels and

- their impact on perceived wellbeing and social inclusion. *Computers in Human Behavior*, 77, 396–405. <https://doi.org/10.1016/j.chb.2017.04.029>
- Papagiannidis, S., Bourlakis, M., & Li, F. (2008). Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses. *Technological Forecasting and Social Change*, 75(5), 610–622. <https://doi.org/10.1016/j.techfore.2007.04.007>
- Puccinelli, N. M., Goodstein, R. C., Grewal, D., Price, R., Raghurir, P., & Stewart, D. (2009). Customer experience management in retailing: Understanding the buying process. *Journal of Retailing*, 85(1), 15–30. <https://doi.org/10.1016/j.jretai.2008.11.003>
- Rampino, L. (2011). The innovation pyramid: A categorization of the innovation phenomenon in the product-design field. *International Journal of Design*, 5(1), 3–16. <http://ijdesign.org/index.php/IJDesign/article/view/645/325>
- Rehm, S. V., Goel, L., & Crespi, M. (2015). The metaverse as mediator between technology, trends, and the digital transformation of society and business. *Journal For Virtual Worlds Research*, 8(2). <https://doi.org/10.4101/jvwr.v8i2.7149>
- Resnick, P. (2005). Impersonal sociotechnical capital, ICTs, and collective action among strangers. In *Transforming Enterprise: The Economic and Social Implications of Information Technology* (pp. 399–412). The MIT Press.
- Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle*. Harvard University Press.
- Shin, D. H. (2016). Cross-platform users' experiences toward designing interusable systems. *International Journal of Human-Computer Interactions*, 32(7), 503–514. <https://doi.org/10.1080/10447318.2016.1177277>
- Shin, Y., Im, C., Oh, H., & Kim, J. (2017). Design for experience innovation: Understanding user experience in new product development. *Behaviour & Information Technology*, 36(12), 1218–1234. <https://doi.org/10.1080/0144929X.2017.1368709>
- Sigerson, L., & Cheng, C. (2018). Scales for measuring user commitment with social network sites: A systematic review of psychometric properties. *Computers in Human Behavior*, 83, 87–105. <https://doi.org/10.1016/j.chb.2018.01.023>
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behavior in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- Stephenson, N. (1992). *Snow crash: A novel*. Bantam Books.
- Tom Dieck, M. C., & Han, D. I. D. (2022). The role of immersive technology in customer experience management. *Journal of Marketing Theory and Practice*, 30(1), 108–119. <https://doi.org/10.1080/10696679.2021.1891939>
- Veryzer, R. W. (1998). Key factors affecting customer evaluation of discontinuous new products. *Journal of Product Innovation Management*, 15(2), 136–150. [https://doi.org/10.1016/S0737-6782\(97\)00075-1](https://doi.org/10.1016/S0737-6782(97)00075-1)
- Vo, K. N., Le, A. N. H., Thanh Tam, L., Ho Xuan, H., & Palazzo, M. (2022). Immersive experience and customer responses towards mobile augmented reality applications: The moderating role of technology anxiety. *Cogent Business & Management*, 9(1), 2063778. <https://doi.org/10.1080/23311975.2022.2063778>
- Walsh, V., Roy, R., & Bruce, M. (1992). *Winning by design: Technology, product design, and international competitiveness*. Basil Blackwell.
- Wright, M., Ekeus, H., & Coyne, R. (2008). Augmented duality: Overlapping a metaverse with the real world. *Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology*, 263–266. <https://doi.org/10.1145/1501750.1501812>
- Wrigley, C., & Bucolo, S. (2011). Teaching design led innovation: The future of industrial design. *Design Principles and Practices: An International Journal—Annual Review*, 5(2), 231–240. <https://doi.org/10.18848/1833-1874/CGP/v05i02/38037>
- Xi, N., Chen, J., Gama, F., Riar, M., & Hamari, J. (2022). The challenges of entering the metaverse: An experiment on the effect of extended reality on workload. *Information Systems Frontiers*, 1–22. <https://doi.org/10.1007/s10796-022-10244-x>
- Xing, Y., Shell, J., Fahy, C., Xie, T., Kwan, H. Y., & Xie, W. (2022). Web XR user interface research: Design 3D layout framework in static websites. *Applied Sciences*, 12(11), 5600. <https://doi.org/10.3390/app12115600>



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